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Pesticides Abstracts and News Summary

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INSECTICIDES

Vol. 6 No. 1 FEBRUARY 1960

COLONIAL PESTICIDES RESEARCH COMMITTEE
COLONIAL OFFICE, LONDON

The abstracts contained in P.A.N.S. are in general abstracts of interim reports. The conclusions stated are, therefore, tentative and may be modified by the results of subsequent investigations.

Permission to quote from these abstracts or the original papers must be obtained from the authors.

Enquiries should be addressed to: Colonial Pesticides Information Service, Tropical Products Institute, 56/62, Gray's Inn Road, London, W.C.1.

NEWS ITEMS

ARSENITES

During the course of a recent address to the Somerset National Farmers' Union, the Minister of Agriculture, Fisheries and Food, the Rt. Hon. John Hare, O.B.E., M.P., referred to the discontinuation of the use of arsenites:

> "One of the scientific developments which has helped all of us, horticulturists and farmers, to cut our costs and reduce wastage, has been the increasingly effective chemical sprays. Recently, however, there has been much concern about the use of alkali arsenites. As you know, these are used extensively for killing potato haulms. The potential risks here are particularly wide because of the large number of people involved and the danger to cattle. The Advisory Committee on Poisonous Substances which deals with agriculture and food storage recommended that their use should be voluntarily banned. I held urgent consultations with the Organisations concerned, including of course the National Farmers' Union. I am very glad to be able to tell you that agreement has now been reached that the manufacture of alkali arsenites for use in this country as haulm destroyers and weed killers shall now stop, and that after this year's potato harvest the agricultural and ancillary industries will withdraw these arsenites from agricultural use.
>
> "This voluntary ban will not apply to sheep or cattle dips, or to the use of lead arsenate on fruit trees.
>
> "The agreement which we have been able to reach has confirmed my opinion that voluntary arrangements are the best way of looking after matters of this kind. Though the use of these arsenites will continue for another season, I feel that with the support of organisations like the N.F.U. we can make full use of warning publicity to enable us to get through it in safety, and the agricultural chemical manufacturers will be able to push ahead with the development of substitutes.
>
> "This voluntary agreement reflects high credit on all concerned. It inevitably involves some sacrifice by the manufacturers and by the farming community. I should like to pay a sincere tribute in particular to the Association of British Manufacturers of Agricultural Chemicals and to the N.F.U. for the responsible and co-operative way in which they have joined in our negotiations."

(From M.A.F.F. Press Release 7/60 dated 6th January, 1960)

CHEMICAL COMPOUNDS USED IN AGRICULTURE AND FOOD STORAGE IN GREAT BRITAIN

Recommendations, for safe use in agriculture and horticulture of the compound noted below, have been added to those already included in the dossier prepared by the Ministry of Agriculture, Fisheries and Food.

Disodium 7-oxabicyclo (2,2,1) heptane-2, 3-dicarboxylate
("Endothal") Issued: December 1959.

Copies are obtainable from:

Ministry of Agriculture, Fisheries and Food,
5/8, St. Andrew's Place,
Regent's Park,
London, N.W.1.

PEST INFESTATION RESEARCH 1958

The Report of the Pest Infestation Research Board with the Report of the Director of Pest Infestation Research, Department of Scientific and Industrial Research.

INSECTICIDES

Spraying and dusting equipment

"Water-dispersible powder formulations are widely used, especially on the internal fabric of warehouses and stores. Aqueous suspensions of various proprietary water-dispersible powders have been found to differ considerably in their stability and as much as 60 per cent of the insecticide may settle out within four minutes of mixing. Gross errors of dosing have been demonstrated when such formulations were applied with machines lacking an efficient method of liquid agitation. Manufacturers are being urged to incorporate mechanical agitation in appropriate machines, especially the multi-purpose, motorized, knapsack sprayers, to ensure delivery of a uniform dispersion of these wettable powders".

Control of insects in flour mills - use of insecticidal lacquers

"Films of insecticidal lacquers containing dieldrin or endrin are very effective in killing adult flour beetles, Tribolium confusum, confined on them. In tests to determine the protection which might be afforded to the beetles if the film were covered by an accumulation of a powdered foodstuff, a 2-in. layer of flour was found to offer little or no protection and, after removal from the lacquer film, the flour itself proved to have a residual toxicity. Direct contact with the lacquer for as little as three hours was sufficient to make the flour toxic to the beetles. Moreover, a 2-in. layer of flour removed from the lacquer after contact for 14 days did not lose its toxicity during six months storage in an open-topped vessel. Further tests have shown that flour can become toxic to the beetles when separated from direct contact with the lacquered surface by a single layer of "B" twill jute sacking, by a single layer of kraft paper, or by an air gap of $\frac{1}{8}$ in.

A method for the biological estimation of endrin in flour has been devised and tested with very promising results but the accuracy of the method cannot be judged until a chemical check of the endrin content can be made, as some of the insecticide could conceivably be lost during preparation of the reference samples.

Whether any risk of contamination may arise from the restricted application of dieldrin or endrin lacquers in the protection of foodstuffs, such as flour, against insect infestation will depend on many factors, especially the conditions of exposure of the product to the treatment and the amount of dilution to which any exposed product will be normally subjected in subsequent processing. Whilst such factors are being investigated, caution in the use of these particular insecticidal preparations must be advocated".

Evaluation of water-dispersible powders

"Experimental work to determine the relative susceptibility of eight species of stored-product beetles to insecticidal water-dispersible powders has been extended to include diazinon and methoxychlor.

The investigation of the persistence of these formulations at 25°C. and 70 per cent R.H. is continuing. Many of the tests of deposits on filter paper have been completed up to eight months after application and the 16-month tests remain to be done. Two dosage levels are being used, namely 20 and 80 mg. of toxicant per sq. ft., and it is noteworthy that at the lower level only malathion has maintained its lethal effect for eight months. DDT has shown a very slight fall but this may not be significant. Dieldrin and chlorthion have caused only 50 per cent kill after eight months compared to 100 per cent at the start. As reported last year (Pest Infestation Research, 1957, p.20), aldrin and lindane lost most of their toxicity within the first two months. Diazinon and methoxychlor will shortly be added to the series".

The persistence of lindane in whitewash

A comparison has been made of the persistence of the insecticidal effect of lindane incorporated in a water-dispersible powder and in a whitewash. The two preparations were applied to filter papers at dosage rates which would give approximately 80 mg. lindane per sq. ft. in the deposits. Grain weevils (Calandra granaria) and flour beetles (Tribolium castaneum) were exposed on the papers immediately after drying and 1, 2, and 4 months after treatment, using different papers at each exposure. The storage and testing conditions were 25°C. and 70 per cent. R.H.

There was no difference between the effectiveness of the two preparations at the start. After one month the whitewash showed a somewhat reduced effect against the grain weevil and had no effect on the flour beetle; the dispersible powder was still fully effective against the grain weevil but had definitely deteriorated in its efficacy against the more resistant flour beetle. The position was unchanged at the end of the second month of storage but both preparations had lost all toxicity to both species of insects at the end of the fourth month under the test conditions described.

Other topics reported are:

Insecticides

Control of insects infesting groundnuts
Control of the warehouse moth in warehouses
Infestation of a food product by the warehouse moth
Toxicity of pyrethrum to moths
Effects of insecticides on seed germination
The fumigation of insecticidal dusts
Entoleter treatment of wheatfeed
Insecticidal activity of benzene hexachloride samples
Statistical aspects of insecticidal action
Migration of oil over the surface of insects
Effects of insecticides on the oxygen uptake of beetles
The increased resistance of insects to insecticides
Insecticidal activity of beta-triketones
Variation in insect resistance
Acaricides and stored-product mites
Hanging drops for killing flies
Unusual infestations by ants
Evaluation of insecticidal lacquers using cockroaches
Clothes moths

Fumigants

Biological study of fumigation practice
Variations in resistance to fumigants between populations of a species
Resistance of *Tribolium confusum* eggs to fumigation
Resistance of *Trogoderma granarium* larvae to fumigation
Toxicity to insects of mixtures of methyl bromide and carbon dioxide
Toxicity of fumigants to mites
X-ray photography as an aid in tests of fumigant toxicity
Instruments for the estimation of methyl bromide and other fumigants in air
Determination of acrylonitrile in air
Dosages of methyl bromide for different commodities
Fumigation of flour with methyl bromide
Fumigation of tobacco with methyl bromide at atmospheric and reduced pressure
Materials for gas-proof sheets

Biochemistry

Mechanisms of resistance of houseflies to gamma benzene hexachloride and dieldrin type insecticides
Mode of action of insecticides
Radio-paper chromatographic techniques

PEST CONTROL RESEARCH IN THE U.S.A.

1. Nematode Control for Long-Staple Cotton

A chemical method of controlling the root-knot nematode on extra-long-staple cotton now joins crop rotation and summer fallow as a practical means of dealing with this pest.

In recent Arizona studies with several soil fumigants, all treatments raised yield significantly, and DBCP (1,2-dibromo-3-chloropropane) gave highest yield, lowest nematode count. Rotation of cotton with a nematode-resistant alfalfa for 2 or more years is a useful control measure, as is a rotation with small grain and grain sorghum on the land for a year - small grain during the cool months, followed by grain sorghum. Equally effective is fallowing the land, occasionally disking it during the hot months. This reduces nematode survival by keeping the soil dry, and starves nematodes by getting rid of weeds they feed on.

Unfortunately, some growers can't justify these practices because of acreage limitations or for other reasons. Preplanting soil fumigation would seem to be their answer. ARS nematologist H. W. Reynolds, of USDA's Cotton Research Center, Tempe, Ariz., fumigated test plots with several nematocides. These were injected about 8 inches deep and the soil compacted with a roller. The cotton was planted 8 days later.

Other test plots were treated with DBCP adsorbed on clay granules, applied with a fertilizer drill as a side dressing 2 months after planting. Differences in plant size were obvious 4 weeks after seedling emergence, Cotton plants in fumigated plots were larger and more vigorous than those in the other plots. These differences were even more pronounced 10 weeks after emergence. Six months after planting, all the plots were harvested with mechanical pickers and seed cotton weights determined. Plants from each plot were selected at random and examined for root-knot nematodes.

Yields of cotton from soil-fumigated plots were considerably greater and nematode counts much lower than those of the untreated plots and plots treated after planting. The post-planting treatment gave better results than no treatment at all. Plots treated with 4 gallons per acre of DBCP (17.3 pounds of active ingredient per acre) before planting produced 1,041 pounds of lint per acre, slightly more than twice the yield secured from untreated control plots. In addition, roots in the DBCP-treated soil showed only a trace of infection with the nematode. Post-planting treatments resulted in a yield of only 514 pounds of cotton per acre. Infection with root-knot nematodes was moderately heavy. At the 4-gallon rate, DBCP cost about $22 per acre. Application cost was $3 per acre.

(Agricultural Research, Sept. 1959, 8, (3), 6-7.)

2. High Altitude Cosmic Rays Fail to Produce Insect Mutants

In experiments preliminary to manned space flights, no genetic damage to insects has been observed from cosmic radiation that penetrated U.S. Navy balloon gondolas in which the insects were carried nearly 15 miles above the earth, report the U.S. Department of Agriculture.

Fruit flies, house flies, and fleas, carried by the balloons (see earlier press release, USDA-3177, Nov. 14, 1958), remained at altitudes of 78,000 to 82,000 feet for 16 hours under cosmic ray attack 60 times more intense than at sea level. This attack, which did not harm the insects genetically, amounted to an impact on living tissue of as much as 10,000 roentgens for less than a millionth of a second. Results of the experiments, however, do not prove that cosmic rays at such altitudes are harmless to life.

The fruit flies, Drosophila melanogaster, used in this experiment by USDA's Agricultural Research Service scientists, had been bred in laboratories to develop marker genes on the X-chromosome (sex-determining chromosome). Because the genetic makeup of this insect is better known than that of most other insects, mutations of specific characters can be easily observed. In this study, fruit flies returned from the balloon flights, and similar flies kept on the ground for controls, were examined by Dr. Sarah B. Pipkin of Howard University, Washington, D.C. No indication of X-chromosome breakage was found among exposed larvae although the experiment had been designed to reveal such breakage. Furthermore, no increase in gross abnormalities was found in exposed larvae as compared to the controls.

The 10,761 early-stage fruit fly larvae returned from these flights represent only 0.6 cubic centimeter of tissue. The radiation frequency, say the scientists, may have been too low to strike such a small target. No gross genetic effects were apparent in either the house flies, Musca domestica, or oriental rat fleas, Xenopsylla cheopis. Reproduction was normal, and no physical abnormalities were noted by ARS entomologists William Sullivan and Carroll N. Smith.

The entomologists are contemplating similar experiments with insects to be sent aloft on recoverable satellites that orbit in the Great Radiation Belt. This belt reaches its first peak of radiation intensity at an altitude of about 2,400 miles. Another peak occurs at 10,000 miles. In each peak band, the rate of bombardment by electrons is equal to about 10 roentgens per hour and that by protons to about 100 roentgens per hour.

(U.S. Department of Agriculture, Washington, November 20, 1959. For P.M. Release December 3. USDA 3307-59.)

3. 45th Mid-Year Meeting of the Chemical Specialties Manufacturers Association, Inc. (Drake Hotel, Chicago, May 18-20, 1959.)

Aerosol Division

Contributions included papers on (1) Du Pont's Freon C-318 (octafluorocyclobutane) as a propellant for aerosol food products, and (2) the evaluation of spray deposits and the inhalation of particles from pressurised sprays. Other topics discussed included:
(3) rheological characterisation of formulations for pressure packaging and (4) propellant blending.

Insecticide Division

The meeting this year assumed the form of a symposium on fly control. Papers were given on fly control methods as practised in Oklahoma (5) and New York (6). On fly control for the dairy herd, Fisher (7) noted the replacement of DDT and other residual insecticides by quick knockdown sprays preferably possessing some repellent effect, together with diazinon for hand spraying barn walls and ceilings. In addition, malathion and Korlan have been recommended for the treatment of cattle manure in pens for the control of fly maggots.

McDuffie (8) reviewed the problem of the control of flies affecting man and animals, including hornflies, stableflies, soldierflies and the biting flies, (hornflies, stableflies, horseflies and deerflies) and flies causing myiasis. He indicated that intensive screening of materials for effect as animal protectants is in progress and noted that "without question the greatest need of the livestock industry today is for a long lasting animal protectant."

Hall (9) referred to the use of insecticides against mosquitoes and to spraying equipment for this purpose. He also referred in general terms to the use of molluscicides and germicides.

References

(1) F. W. Blodgett & R. C. Webster. (2) A. H. Yeomans and R. A. Fulton. (3) L. Cohen, R. J. Meyer and J. S. Wolff.
(4) E. E. Husted. (5) D. E. Howell. (6) H. H. Schwardt.
(7) E. H. Fisher. (8) W. C. McDuffie. (9) L. B. Hall.

(compiled from the Proceedings published in 1959.)

NEWS ITEMS FROM THE COMMONWEALTH

AUSTRALIA - WESTERN

San Jose scale, Quadraspidiotus perniciosus, control

Author's Summary: "Some observations have been made on the life cycle and habits of San Jose scale under West Australian conditions. Five generations may occur, but this is subject to climatic variation.

Large scale field trials of dormant sprays, viz., lime-sulphur followed by Superior dormant oil, have shown that while these materials give good control of scale, they are not sufficiently effective to meet the recently imposed phyto-sanitary export requirements.

Post-harvest sprays have been shown to cause a large reduction in the scale population, Gusathion at 0.05 per cent plus dormant oil at 3 gallons to 100 gallons, being more effective than diazinon at 0.05 per cent plus dormant oil at 3 gallons to 100 gallons.

Summer treatments of parathion, Gusathion and diazinon at 0.05 per cent plus a summer spraying oil, have been demonstrated to be more effective than the previously recommended malathion which was shown to have exerted a considerable degree of control.

Discussion: The efficiency of parathion, Gusathion and diazinon as summer controls and Gusathion and diazinon as post-harvest sprays has been clearly demonstrated. The Gusathion and Superior oil treatment in the post-harvest spraying experiment gave a 95 per cent kill of scale present. The conditions existing at post-harvest spraying are closely akin to those experienced during the normal dormant spraying schedule.

It is reasonable to assume that the efficiency of dormant oil spray would be greatly enhanced by the addition of parathion, Gusathion or diazinon at a 0.05 per cent concentration.

Spray equipment must be in first class condition and adequate coverage of trees obtained. This may involve the use of long lances and the removal of loose bark from the butts of trees.

Where concentrate sprayers are used, particular attention should be paid to observe the recommended speed of travel. In this case the trees at the ends of each row should be paid careful attention, as these are often incompletely sprayed, due to an early cut-off.

Control recommendations:

Apples and Pears

Dormant Treatments

Superior Oil: Three gallons to 100 gallons water. The efficiency of the dormant oil spray will be increased by adding Gusathion, diazinon or parathion as recommended for summer treatments.

or

Lime-Sulphur: Ten gallons to 100 gallons water. Applications to be made in late August or early September. When the oil spray is used this should approximate as close as possible to a fortnight prior to bud burst.

Where infestation is severe, two sprayings are required as follows:-

Lime-sulphur during August, followed approximately one month later with Superior oil. The final spraying to be completed by the first week in September.

Summer Treatments

In the case of severe scale infestation one or more summer treatments may be necessary and the following are recommended:

Superior Summer oil or white oil 1¼ gallons to 100 gallons water. Plus Gusathion 25 per cent wettable powder 2 lb. to 100 gallons.

or

Diazinon 20 per cent concentrate two pints per 100 gallons.

or

Parathion 20 per cent concentrate two pints per 100 gallons.

(The above materials have been found superior to 1½ pints 5 per cent malathion to 100 gallons.)

Application times: Late November to early December, mid-January, late February.

Stone Fruits

Winter

Lime-sulphur or Superior oil prior to budburst as recommended for apples and pears.

Summer

As for applies.

(G. D. Rimes, J.Agric.W.Austr., 1959, 8, (5), 587-93.)

Cattle Lice: "Beef and dairy cattle of all ages are liable to lice infestation and these parasites can be responsible for serious financial losses as their presence leads to retarded growth rates and reduced milk yields. This is easily understood when it is realised that lice-infested animals spend much of the time, normally devoted to feeding and rumination, in rubbing and scratching to allay the irritation caused by the parasites".

Species, life histories, symptoms, treatment and control are noted.

Sprays of dieldrin or BHC, at a concentrate of 0.05 per cent., are recommended.

(Vet. Branch. J. Dept. of Agric., 1959, 8, (4), 477-80.)

CEYLON

Beans

Emulsions and dusts of chlorinated hydrocarbon and organophosphorus insecticides were tested as seed treatments for the control of Agromyza attacking seedling beans in five series of trials. All the dusts depressed germination, and gave poor Agroryza control. The organophosphorus compounds did not seriously affect germination but generally gave poor Agromyza control. The chlorinated hydrocarbons as emulsions, as a rule, gave good protection against Agromyza. Endrin gave the best control. In the first series of trials at the end of three weeks, endrin-treated plots showed 1 per cent damage by Agromyza whereas the checks showed 62 per cent damage. In the second series, endrin treatment gave almost complete (0.8 per cent attacked) protection of the crop over a period of six weeks whereas the checks showed 82 per cent attack at the end of that period.

DDT (25 per cent EC 1 and 2 fl. oz. per gallon water) and parathion (47.5 per cent EC 2 cc and 4 cc per gallon water) used as foliar sprays on bean seedlings either at weekly intervals or at fortnightly intervals gave complete control of Agromyza.

Rice

Blast control: A large number of dust formulations was tested by a bioassay method for their efficacy in inhibiting the germination of Piricularia spores. Copper fungicides were not efficient even at 50 per cent active ingredient. "Fermate" was efficient at 0.25 per cent. The mercurials inhibited spore germination at dilutions of 0.12 per cent.

The efficiency of various fungicides for the control of blast was investigated. The mercury formulations were consistently superior to the presently used fungicides "Perenox (copper oxide) and "Fermate" (ferric dimethyl dithiocarbamate) fungicides. In general 25 per cent to 35 per cent control obtained with "Fermate" and "Perenox" has been raised to 75-85 per cent with the most effective mercurials. Among the mercury based fungicides the most effective are phenyl mercuric acetate and slaked lime (0.25 per cent Hg) and phenyl mercury paratoluene sulphonanilide and lime (0.25 per cent Hg). Lower dilutions of the former containing 0.125 per cent, 0.075 per cent and 0.038 per cent Hg respectively, were also effective but slightly inferior to the 0.25 per cent formulations.

The alkyl dusts, ethyl mercury chloride and lime (0.25 per cent Hg) and ethyl mercury phosphate and lime (0.25 per cent Hg), are more effective than the wettable phenyl compounds, phenyl mercuric acetate, phenyl mercuric paratoluene sulphonanilide and phenyl mercuric dinaphthyl methane disulphonate, but are less effective than the phenyl dusts.

Phytotoxicity of mercury compounds: Although mercuric fungicides are non-toxic to Japonica varieties of paddy, evidence of considerable phytotoxicity of these mercurials to Indica varieties of paddy was observed, the effects manifesting themselves as systemic yellowing or necrotic lesions. The promising mercurials were therefore tested in a series of experiments on a large number of paddy varieties.

Ethyl mercury chloride - lime and ethyl mercuric phosphate - lime combinations are almost non-toxic. Phenyl mercuric dinaphthyl methane disulphonate was only slightly so. Other mercurials are phytotoxic in varying degrees. It was also found that during the emergence of the panicle the rice plant was even more susceptible to mercury than at its earlier stages. The non-toxic mercurial compounds are presently recommended for use in paddy seed farms only.

Stem borer Schoenobius incertellus: In the Yala trials at Panagoda, parathion (47.5 per cent, endrin 20 per cent EC, and Dipterex 50 per cent EC were applied at either of 2 concentrations, viz.:-

(a) endrin at 1 fl oz in 2 and 4 gal.

(b) parathion at 2 cc and 4 cc per gal.

(c) Dipterex at 4 cc and 8 cc per gal.

Spray application was done with a double knapsack boom sprayer at the rate of 40 to 60 gallons of spray per acre. The crop received 5 sprayings during the season. The results showed the following yield increases over the untreated plots:-

Insecticide and Concentration	Yield Increase per Acre
Endrin - high concentration	17.3%
Endrin - low concentration	15.6%
Parathion - high concentration	9.0%
Parathion - low concentration	8.2%
Dipterex - high concentration	Below check plots
Dipterex - low concentration	Below check plots

This trial was repeated at Panagoda in the Maha season with the inclusion of DDT and applying only the higher concentration of the insecticides and either at fortnightly intervals or at peak moth emergence periods. "Dipterex" was used at a slightly higher concentration of 9.5 cc per gal. in this trial. Dead-heart counts indicated the endrin gave the best control followed by parathion and then DDT. "Dipterex" treated plots showed a higher dead-heart count than the untreated plots.

Two distinct peaks of moth populations were observed, the 21st August and the 15th September, and between the 1st November and the 1st December.

In the Mirigama range, dead-heart counts showed that endrin gave the best control of stem borer followed by parathion and Shell "WL 1650," while "Dipterex" gave the poorest control.

Grain Storage Pest Control - Sitotroga cerealella: A trial at Hingurakgoda showed that treatment of the grain with malathion 0.4 per cent dust at 2.25 oz per bushel resulted in only 0.2 per cent damage to the grain during 6 months storage whereas the untreated checks showed 16 per cent damage in this period. A combined bag spray with grain treatments did not give superior results to grain treatment alone with malathion. Bag spraying alone with malathion gave only 2-3 per cent loss of grain over 6 months storage. The malathion treatment did not affect germination.

(Administration Report of the Director of Agriculture for 1958, August, 1959.)

Rubber:

Oidium heveae: On one estate severely affected with Oidium a new type of dusting machine, the electroduster, showed some advantage over the type of sulphur dusting machine in common use.

Phytophthora palmivora: Ten field experiments covering a total area of 248 acres distributed over 5 estates were carried out during the year to test the relative effectiveness of copper-based, organo-metallic and organic fungicides. The copper-based dusts proved to be the most effective and the most economical, no difference being found between cuprous oxide and copper oxychloride preparations or between the various proprietary brands of fungicide containing 4 per cent copper. A rate of application of 8-10 lb per acre, with dusting rounds spaced at about 5-day intervals, gave adequate protection.

A proprietary copper-based dust with a special incorporated sticker and containing 1 per cent copper was found to be as effective as ordinary copper-based dusts containing 4 per cent copper.

Two experiments were carried out to compare electrostatic dusting with normal dusting. Contrary to the result obtained during the Oidium season with sulphur dust, no difference could be found between the two methods when using copper dusts, although a special dust supplied by the makers of the electrostatic unit was tried.

This may be mainly due to the fact that the electrostatic dusting method works better the drier the leaves and the lower the humidity of the air, conditions hardly ever obtainable during the Phytophthora season.

Experiments on the control of bark rot disease of the tapping panel caused by Phytophthora palmivora have shown an organo-mercury compound, "Antimucin", to be the most effective water-miscible fungicide tested. Laboratory results have been amply confirmed by large-scale field trials.

Fomes lignosus: Laboratory tests of different chemicals for the control of Fomes lignosus, the fungus causing the white root disease of rubber trees, have shown an organo-mercury compound, "Tillex Liquid", to be the most effective of all fungicides tested. "Tillex Liquid" has, moreover, given excellent results under field conditions for the curative treatment of young rubber trees attacked by Fomes lignosus.

(The Rubber Research Institute of Ceylon, Annual Report for 1958, March, 1959.)

GHANA

Capsid control trials

After two full seasons field trials in the Eastern Region (with both small-scale and large-scale units) using endrin, dieldrin, aldrin, 'Gammalin' and malathion, a sufficient mass of data has accumulated to make continuation of these trials unnecessary. Dieldrin and malathion have been eliminated for use against capsids, the former on account of the danger of a subsequent increase in Marmara, the latter because of sub-standard control at economic dosages. In Ashanti the trials with endrin, aldrin and 'Gammalin', at dosages approximately in inverse proportion to the cost will continue.

With both series of trials the same general picture appears, as with earlier preliminary trials in 1956. Comparing similar dosages of toxicant, endrin is outstanding in its control, 'Gammalin' and aldrin being next in order of efficiency. In all trials aldrin is consistently less effective than 'Gammalin' but the differences between the two are very small - of the order of 3 per cent difference in the numbers of damaged trees per 1,000 trees. Aldrin has therefore been considered suitable for capsid control in Ghana, provided the retreatment is at the 2 oz. rate of application.

Laboratory assessment of insecticides

Continued difficulty is being experienced in the laboratory breeding of capsids. The mass breeding technique has been interrupted owing to a seasonal decline in capsid reproduction. A colony of Dysdercus spp. (Pyrrhocoridae) is being established and preliminary indications are that this insect is sensitive over the same range of gamma-BHC concentrations as cacao capsids and is also more robust and easier to rear in the insectary. Bioassay with this insect should prove a useful cross reference in the investigations on the efficacy of various gamma-BHC formulations now being undertaken.

(West African Cocoa Research Institute, Tafo, Ghana, fifty-third Quarterly Report, Jan.-Mar., 1959.)

MALAYA

Rubber: "Observations on the residual toxicity to Coptotermes curvignathus of soil treated with chlorinated hydrocarbons have been in progress for several years and are approaching completion. After 34 months, dieldrin has lost its toxicity in clay but remains active in all other soils with the exception of peat. The other three insecticides tested - chlordane, aldrin and endrin - had earlier lost their effectiveness in all the soils. The study of insecticidal activity in peat, which rapidly inactivates all of them at dosages which are fully effective in other soils, is being pursued at much increased dosage rates.

Seven outbreaks of cockchafer grubs, four of Psilopholis vestita and three of Holotrichia bidentata, were reported by estates in Perak, Pehang, Negri Sembilan and Malacca. The former species involved both mature and immature rubber, and the latter only immature rubber. Treatment similar to that adopted against termites - watering the soil with aqueous emulsion of insecticides - has been tried as a method of protecting immature trees in four of the outbreak areas. Four pints of 0.1% aldrin or 0.04% gamma BHC gave complete control of the feeding grubs of Holotrichia bidentata. Gamma BHC appeared to be quicker in its action than aldrin, but it is known that aldrinwill persist much better in the soil.

Insecticidal applications designed to protect scorched trees from invasion by boring beetles have been unsuccessful. It appears that the parts of the tree penetrated by the borers are already damaged beyond recovery, and that the beetles do not make the condition any worse.

Tests with insecticides against pests of legume covers have shown DDT to give good results against the ladybird beetle, Epilachna indica, while endrin is preferred for treating caterpillars."

(Rubber Research Institute of Malaya, Annual Report, 1957.)

Forestry control measures

Trees: Dieldrin continued to be used against all cases of termite attack, while "Gammexane" products were still being used in planting holes. Both these insecticides were also used effectively in the control of defoliators. DDT was once again used effectively in the control of defoliators of 40 acres of *Albizzia falcata*.

Freshly Felled timber: A spot test of three proprietary insecticides, "Endrex", "Dieldrex 15" and "Hexastan" against ambrosia beetles was started. The test will be concluded early in 1959.

Converted timber: Boric acid treated boards /*Dyera costulata* Hk.f. (Jelutong)/ are free from attack of powder-post beetles five years after treatment.

(Report on Forest Administration for the Year 1958.)

Forestry

Testing of insecticides against sub-terranean termites: Prior to 1953 no special tests were carried out in the control of termite attack on trees. During the period 1953-58 several insecticides were tested. "Intox 8" was used effectively in the control of root feeding termites. "D-D" soil fumigant though very effective in killing active infestation of termites in buildings or termite colonies, is not recommended for use against termites attacking trees due to its phytotoxic effect. Jelutong (*Dyera costulata* Hk.f.) appeared to be the only tree (out of more than twenty species treated) unaffected by the fumigant. Dieldrin was commonly and effectively used in the control of subterranean termites attacking trees of various species. It reduced the mortality of *Eucalyptus* seedlings from 15% to about 2%. Dieldrin was also used in buildings as a prevention against termite attack. "Gammexane" products were used effectively in planting holes against termite attack.

During 1958 dieldrin continued to be used against all cases of termite attack, while "Gammexane" products were only used in planting holes.

Testing of insecticides against defoliators etc.: Prior to 1953 no special insecticidal tests were carried out in the control of defoliators, stem borers, etc. Between 1953-58 orthodichlorobenzene and paradichlorobenzene were used very effectively in the control of cossid moth borers of trees, particularly *Eucalyptus*. Dieldrin, DDT and "Gammexane" products were used with success in the control of beetle and moth defoliators in nurseries and plantations. Emulsions of dieldrin were specially favoured due to its longer residual effect. Shoot boring ants and bark eating caterpillars were killed by dieldrin sprays. Dieldrin and 'Nicotox' sprayed in alternate series killed a heavy infestation of scale insects on Hibiscus spp.

During 1958 dieldrin, "Gammexane" and DDT continued to be used against defoliators and other insects. Fogging with DDT emulsion provid very effective in stopping defoliation of a forty acre Albizzia falcata Back. plantation in Selangor.

Prevention of insect attack on freshly felled timber: Prior to 1953 it was established that the gamma isomer of BHC is effective in preventing attack on freshly felled timber by ambrosia beetles. More than a dozen insecticides have been tested since then - some of them several times. The results were inconsistent. Some proved to be definite attractants while others proved effective.

Precautionary or control measures against insect attack on converted timber: "Gammexane", pentachlorphenol, orthodichlorobenzene and paradichlorobenzene were used in the control of powder-post beetles prior to 1953. Between 1953-57, "Gammexane", boric acid and dieldrin have been proved effective in prevention of attack: "Lyxastan" has given no conclusive results because neither the treated boards nor untreated boards were attacked. However, "Lyxastan" as well as dieldrin, orthodichlorobenzene and paradichlorobenzene (the last two mixed in kerosene) are good at stopping active attack.

(Research Pamphlet No. 26. Research Programme 1958-1962, including a summary of work accomplished in years 1953-1957 and a progress report for 1958. Forest Research Institute, Forest Department, June, 1959.)

NEW ZEALAND

Pip fruits - It is reported that of the newer therapeutants greater use was made of karathane and sulfane for powdery mildew control. Metasystox was also widely used as a systemic insecticide for control of red mite. Parathion and diazinon were also much used in Hawke's Bay pear orchards to combat mealy bug.

At Roxburgh a trial of new therapeutants for control of powdery mildew on Jonathan apple trees has given the following results at the end of three years:

Lime sulphur (1:30) at green tip, sulfane (2 lb) from tight cluster to first cover inclusive, followed by karathane (1 lb) to the end of the season, was much superior to the standard sulphur programme. Substitution of karathane from second cover spray onward in the sulphur programme did not improve control.

Replacing lime sulphur with colloidal sulphur from open cluster to first cover seriously reduced the effectiveness of the standard sulphur programme. Fruit sprayed with sulfane and karathane was of superior finish and colour.

The trial showed that cutting out infected wood at winter pruning is essential to the control of mildew.

In a two-year trial at Motueka on Delicious trees severely infected with black spot, post-harvest sprays of PMC("Ascospray") at 5 lb - 100 gal significantly reduced crop infection in both years. Lime sulphur at $8\frac{1}{3}$ gal-100 gal and Bordeaux 10:8:100 gave no significant reduction the first season, but were as effective as PMC in the second year. "Phygon XL" at $2\frac{1}{2}$ lb-100 gal was not superior to the check treatment, which included no post-harvest spray. Checks and treated trees all received a captan and colloidal sulphur programme during each growing season.

At Hastings, mealy bug was effectively controlled on Williams Bon Chretien pear trees up to the time of harvesting by one spray of diazinon at 1 pint-100 gal applied on 8 November.

Stone fruits - In trials capsid bug damage on peaches was controlled by pre-blossom sprays of DDT, while leaf spotting and fruit damage on nectarines, caused by an eriophyid mite, was also prevented by insecticides applied at the pink stage.

Captan, widely used as a fungicide, was tested, on the basis of overseas reports, for preventing rain cracking of cherries. Under New Zealand conditions it was not successful.

Berry fruits - Raspberry aphis (Aphis idaei), formerly confined to Christchurch, has been reported from Nelson and Waimate. Trials have shown that this pest can be controlled in the egg stage by tar distillate sprays applied in July.

Citrus fruits - Of the newer therapeutants, metasystox was used with success for the control of aphis and red mite (Paratetranychus citri) in citrus nurseries. Malathion plus oil sprays has continued to be used with success to control scale insects in orchards.

Viticulture - Thiram is being used more extensively where black spot has been a problem. As a specific for black spot thiram has given good results, but has proved less efficient than copper sprays against downy mildew.

In recent years the mealy-bug population in vineyards has been increasing, apparently through an acquired resistance to DDT, which is still the main insecticide used.

In some cases severe infestations have been checked by the use of parathion, malathion, and diazinon, and satisfactory control has been claimed with DDT at higher concentrations than were formerly used.

A few growers have adopted recently the principle of biological control for mealy bug, which has been applied successfully overseas, and the results here so far are promising. Sprays such as DDT and the organo-phosphates, which are harmful to useful predator insects, are avoided. In this way the predator insects of mealy bug are encouraged to multiply and control the mealy-bug population.

Another observation which may be related to the use of DDT through the destruction of useful predator insects has been the increase in the red spider population in many vineyards. The damage caused by red spider (Tetranychus sp.) on outdoor vines in recent years is difficult to assess, but it could be more significant than is generally supposed.

Air-blast spray equipment for concentrate and semi-concentrate spraying is superseding the old pressure-spraying units on most of the larger vineyards. As less expensive air-blast spray equipment becomes available smaller vineyards are expected to adopt the new spraying method.

Bird damage overshadows all other pest problems in the vineyards, especially in the Henderson district. The main defence against the depredations of birds is still the shotgun, supported by bird-scaring devices exploding charges of carbide at frequent intervals.

Beekeeping - Assistance was given with trials to determine the toxicity to honey bees of several therapeutants when applied to flowering crops for the control of insect pests.

The effects of DDT emulsion when sprayed aerially to flowering chou moellier were observed. DDT emulsion repelled bees for six days after the application and caused only slight field-bee mortality. Where flowering brassica crops must be sprayed to save them from destruction by insect pests, DDT emulsion would be suitable for use provided applications were made before field bees began foraging flights.

The effect of thiodan was also observed. Thiodan applied to flowering chou moellier exerted no repellency and was found to be more lethal to field bees than DDT. Trials demonstrated that thiodan applied to flowering brassica crops would cause serious bee mortality.

Rogor, endothion, and MGK repellent 874 were also tested. Rogor, in combination with MGK repellent 874 was applied from the air to a crop of flowering turnips. Endothion was applied to a flowering crop of rape.

No repellency was exhibited by the Rogor-MGK repellent 874 mixture or by the endothion.

Rogor proved highly toxic to field bees, though brood was unaffected. The test indicated that rogor should on no account be applied to flowering crops attractive to honey bees.

Endothion caused no bee mortality and is safe to apply to flowering brassica crops.

(Report of the Department of Agriculture for the Year ended 31st March, 1959.)

SOUTH AFRICA

Wattle bagworm, Kotochalia junodi, control

Commercial spraying campaign, 1958-59: Over 5,000 acres were surveyed and 3,087 selected for aerial treatment. In all, 3,266 acres were sprayed and the application was supervised over 2,403 acres. The insecticide used was toxaphene dissolved in light diesel oil at the rate of 0.75 lb per gallon of solution; 1,320 acres were treated with 2 gal/acre and the remainder with 3 gal/acre. The aircraft used was a 295 h.p. Percival EP9 monoplane, equipped with 41 type D8 spray nozzles and with a tank holding 180 gals of insecticide. Usually only 90 gal were carried on one flight, with a few exceptions when plantations growing at lower altitudes were sprayed very early in the morning; the load then consisted of 135 gal. The plane, flying at 90 m.p.h., used a pressure of 35 lb/sq. in to apply 2 gal per acre and 45 lb when discharging 3 gal. The campaign started on 12th and was concluded on 21st November, 1958. In all, there were 6 spraying days, the actual time of flying and spraying being 26 h. 6 min, or 4 h 21 min of flying and spraying per day. The average daily total was 500 acres, i.e. slightly less than 2 acres per minute of flying time (1.72 acres per minute when spraying 3 gal/acre and 3.04 acres per minute with 2 gal). No "swathing" flags were used, and nearly all plantations were marked off into blocks of 50 acres or less.

The outcome of the campaign was assessed over 3,146 acres. The plantations were surveyed from the air and, in some doubtful cases, from the ground also. The aerial survey (from Port Shepstone to Piet Retief and Swaziland) was completed in eight flying hours, against an estimated 14-16 days for ground survey, with a saving of some 25% in costs. The general outcome of the spraying was satisfactory when the recommended dosages were applied. On only some 30 acres, or approximately 1.2%, was there unsatisfactory control. This was due to operational faults on approximately 5 acres; in the remaining 25 acres, the failure was traced to biological factors.

Biological control (Virus disease in bagworms): In the 1957 experiment, it was found that when the infestation was in the prodromal stage and the larvae were in their first instar at the time of treatment, there was no marked difference in mortality whether the suspensions contained 1,000 or 500 virus polyhedra/cu. mm. Concentrations of 250 polyhedra/cu. mm gave a lower kill, but mortality was still high enough to keep the crowns of the trees green. With the higher concentrations, the progress of the cycle was greatly accelerated and the eruptive stage and the crisis occurred later in the same season, whereas with the lowest concentration, the infestation decreased gradually after spraying. Against older larvae, the initial mortality was two low to prevent defoliation, but nine months after spraying, the mortality had increased sufficiently to reduce the infestation to its basic level.

Where virus was applied during the eruptive stage, there was a very high initial mortality and defoliation of trees was light, whereas untreated trees were completely defoliated. Nine months after spraying, however, mortality was equally high in treated and untreated plantations.

The kill up to about six months after spraying was consistently higher where virus of introduced stock was applied than with suspensions containing local material or a strain of suspected low virulence. Nine months after treatment, there was no difference between introduced and local virus, but the virus of low virulence, although an introduced strain, still gave a lower kill. When applied at the prodromal stage of infestation, the introduced virus was more effective than the others in preventing defoliation and so avoiding loss of bark and wood increment.

Methyl cellulose used as a sticker made no appreciable difference to mortality, but skim milk powder reduced it because of adverse effects on the suspension.

A paper reporting this experiment has been accepted for publication (Ossowski, 1960.)*

(Wattle Research Institute, Report for 1958-1959 (Twelfth Year)).

WESTERN SAMOA

Coconut: The most important development in the quarter was the beginning, on 2 March, of a trial with liquid crown treatment using dieldrin reinforced with coumarone resin. While it is too early to make any estimate of its effectiveness, it has proved to be a very much quicker operation than the sawdust and "Gammexane" treatment. During the trial period trees were treated at nearly three times the normal rate. The cost of chemical per tree is about half that of "Gammexane". Treatment of sawdust dumps was continued.

(Department of Agriculture, Forests, and Fisheries, Information Circular, Vol. 4, No. 4, April, 1959.)

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*Ossowski, L. L. J. (1960). The Biological Control of the Wattle Bagworm, Kotochalia junodi (Heyl.), by a Virus Disease. Part II. Large-scale Experiments. Ann. app. Biol. (in the Press).

NEWS ITEMS FROM THE COLONIAL TERRITORIES

BRITISH GUIANA

Malaria control: The routine schedule of the activities of the Mosquito Control Service were limited to the entomological check surveys on the coastlands; spraying operations with DDT of certain strategic areas was carried out according to plan. A total of 11,396 houses and 596 other buildings was sprayed with DDT solution based on the policy of a 12-month cycle for the Interior and Riverain Settlements and an 18-month cycle for the coastlands.

Routine check surveys showed as usual a predominance of Culex fatigans to the extent of about 99 per cent. There was no trace of Anopheles darlingi or Aedes aegypti.

Coconut: Dieldrin continued to be effective against the giant moth borer.

Rice: The heaviest incidence of blast disease of rice (Piricularia oryzae) ever experienced, took place during the year. Approximately 1,000 acres were severely affected on the riverain areas. Spraying experiments with organo-mercurial fungicides and a search for resistant varieties commenced.

Ant control: Leaf cutting acoushi ants (Atta spp.) continued to damage farmers' crops but a new method of control by fogging with aldrin and chlordane insecticides mixed with diesel oil has been developed and has been proved very effective.

(Report for the Year, 1958).

CYPRUS

Vine pests and diseases: It is reported that apart from minor outbreaks of downy mildew in certain places the vines were relatively free from pests and diseases during the season. An outbreak of Esca (Polyporous igniarius) was, however, observed, especially on old vines grown on relatively deep and moist soils. Sodium arsenate was applied with satisfactory results.

(Dept. of Agriculture, Annual Report for 1958, Annexure III, Annual Report on Viticulture.)

FIJI

Coconut: Rhinocerus beetle control

Field operations: "At the end of the year 1958 it was found that expenditure was exceeding the rate of £60,000 per year for which the Board had budgeted. Hence the number of personnel employed had to be reduced by one-third, and field operations had to be correspondingly curtailed. Climbing and treatment of palms ceased all along the south coast, from a point a few miles west of Suva, except for occasional treatments around Navua. Work also ceased in inland areas, such as the valleys of the rivers Wainibuka, Wainimala, Waidina, Waimanu and Rewa, and activities have been reduced on the north-eastern coast of Viti Levu. Most of our efforts are now concentrated in the south-eastern corner of the island, where populations of Oryctes are highest, and from which the danger of the infestation's spreading to other copra-producing islands is greatest. During the year a total of 650,000 palm-crown treatments with BHC and sawdust mixture was carried out. At present, with our reduced staff, treatments are being carried out at a rate of fewer than 500,000 per year. BHC powder is still issued to sawmillers within the infested area for treatment of their sawdust output.

It is of interest that crown treatments of palms around the port of Apia in Western Samoa have been very effective in protecting the palms in that area. The entomologist of the Department of Agriculture in Apia reports that 2,000 palms have been given regular crown treatments over a period of two years, and there has been a marked reduction in damage caused by Oryctes".

Biological control: Work on the breeding and distribution of the introduced parasite, Scolia ruficornis, is continuing. So far the parasite has not been found in natural breeding places.

(Coconut Pests and Diseases Board, Report for period 1st June, 1958 to 31st May, 1959. Legislative Council Paper No. 30 of 1959.)

KENYA

Bilharziasis: It has been decided to change the control measures which have been in force in the various irrigation schemes. Copper sulphate has been added continuously to the water passing into the irrigation channels, with the intention of excluding snails. It is now proposed to cease continuous dosing but to continue with the surveillance of potential human hosts and to dose the water with sodium pentachlorophenate at approximately six monthly intervals and in a concentration of 10 parts per million which, it is calculated, will kill all snails in the irrigation system.

(Medical Department Annual Report, 1958.)

Tsetse Control

Simba: In one area, an experiment to see whether Glossina pallidipes could be reduced by insecticidal spraying in the face of strong pressure from fly outside the treated area was begun. The treated area consisted of a block of seven square miles of country very heavily infested with G. pallidipes. Roads of access were cut at intervals of 1,000 yards, and within these, "spray" paths were slashed 200 yards apart. "Dieldrex" 15, diluted to a 2 per cent. emulsion, was used. The whole area received one complete application of insecticide and part was treated a second time. Unfortunately, owing to trouble with coagulation of the emulsion, the work had to be suspended until a new formulation could be supplied. In spite of this, the fly numbers were reduced by about 90 per cent. Ten new fly patrols were created for this experiment and a notable feature of them was the very high proportion of male flies caught.

Central Nyanza: Weekly fly patrols were maintained until October on Sifu Island, the Utonga peninsular and Chausu Point to discover how quickly re-infestation would take place following the discontinuation of experiments on the cheapest method of exterminating G. palpalis from the lakeside. After October, only three monthly inspections were made to determine the extent of re-infestation caused by natural dispersal and transportation by canoes, vehicles and pedestrians. The most important point which emerged from these experiments was that much insecticide can be saved by applying it along paths 40 yards long, leaving untreated lengths of 60 yards.

South Nyanza Surveys revealed a heavy infestation of G. palpalis on a two-mile stretch of the Oluch river, where two cases of sleeping sickness were contracted in 1957. This area was treated with four applications of "Dieldrex" 15, diluted to a 2 per cent emulsion, at three-weekly intervals, beginning in January and ending in March. Since then no flies have been caught there. Near the Homa Lime Works a strip of lake shore vegetation 14 miles long, harbouring G. palpalis, was similarly treated with "Dieldrex" between July and September. No flies have been caught there since November. In the Lembwe Valley, E.A.T.R.O. completed their investigations in March, when tsetse control was taken over by this Department. Regrowth has become a serious factor in the fly barrier and G. pallidipes is able to disperse into the settlement. In the Kuja-Migori area, the insecticidal operations have progressed satisfactorily. About 400 miles of river has been treated, and the great Kabwoch forest, with its numerous branches, is in the process of being sprayed. So far, the results have been good.

Tick control

In view of the continued spread of resistant strains of Boophilus, the testing of new dipping and spraying materials is of obvious importance. During the course of the year, pyrethrum extract, a new chemical R.D. 6809 manufactured by Boots Pure Drug Co., and Asuntol, in the form of "Agridip" distributed by Agricura Laboratories Ltd., have all been tested. Of these, pyrethrum extract has been given the most prolonged trials, with a view to discovering new uses for locally-grown pyrethrum. A field experiment in conjunction with the Pyrethrum Board of Kenya, was carried out on a farm at Njoro, and further trials at the laboratory were continued at weekly intervals for a period of six months. The following conclusions were reached:-

(a) By spraying at a strength of as little as 0.0075 per cent. pyrethrins, most of the resistant blue ticks on cattle can be destroyed.

(b) Weekly spraying at 0.01 per cent. will control blue ticks, but cannot be relied upon to control three-host ticks. It was found that, despite spraying at weekly intervals, nympths of Rhipicephalus appendiculatus were managing to engorge.

(c) In view of this, pyrethrum in its present unstabilized form would have to be used at shorter intervals, or with some other spraying material. This makes it an expensive method of tick control.

Boots R.D. 6809 was tried only on a small scale and for a short period. It was used as a spray at 0.05 per cent and appeared to have very little residual effect. Six days after spraying, cattle were found to be harbouring engorged R. appendiculatus and R. simus.

The organo-phosphorus compound, "Asuntol", in its present form of "Agridip", has proved effective as a spray when used at weekly intervals and at a concentration of 400 p.p.m. Four different species of tick were found feeding on unsprayed control cattle in the same paddock, but, during the seven weeks of this experiment, no ticks were observed to be engorging successfully on any of the sprayed cattle.

(Veterinary Department, Annual Report, 1958.)

NORTH BORNEO

Malaria: The vector of malaria in most parts of North Borneo is Anopheles leucosphyrus balabacensis but it is also considered probable that in certain coastal districts the vector may be Anopheles sundaicus. Entomological results also indicate that Anopheles barbirostris, which has been found infected with sporozoites, may at times act as a carrier.

Until December 1958 a reliable method of stopping the transmission of malaria in the project areas had not been discovered. However, the results of twice annual spraying with a residual insecticide (either DDT or dieldrin) coupled with mass administration of anti-malarial drugs, namely, chloroquine and pyrimethamine given at the time of spraying have shown that transmission can be completely interrupted. Following on these encouraging results, expansion of the spraying (which has hitherto covered only the Interior Residency and the island of Labuan) is planned for the year 1959. It is probable that DDT will remain the insecticide of choice in the expansion areas and that spraying will be conducted on a twice annual basis combined with the use of anti-malarial drugs at the time of spraying.

(Annual Report of the Medical Department for the Year 1958.)

RHODESIA AND NYASALAND

Trypanosomiasis - Urungwe: Preliminary surveys for an experimental attempt to eliminate tsetse from the Kapondo area by the application of dieldrin (Dieldrex) to the riverine and termite mound vegetation were undertaken, and observations on a number of flyrounds begun. The first spraying, using 689 gallons of 1.8 per cent. dieldrin, applied by portable spraying, was carried out at the end of the year under review. It is as yet too soon to assess the results of this work.

Stored products insects - Maize: "Phostoxin" was used extensively at the Aspindale silo and it has virtually cleared the infestation, Maize treated with "Phostoxin" has been stored for periods of up to seven months and has remained free of infestation. There has as yet been no case of breakdown in the protection given. Many of the bins at the silo have been repaired and methyl bromide, which is of course much cheaper than phostoxin, has been successfully used on four of these. A new circulation plant for methyl bromide is in course of construction and should come into use early next year.

Deciduous Fruit: Protective sprays of 4:6:50 Bordeaux mixture reduced the incidence of bitter rot in apples from 18.3 per cent. in the controls to 0.7 per cent., but caused considerable injury to the fruit and foliage, most of which developed early in the season. Ferbam and Maneb were less effective in preventing infection, but caused no phytotoxicity. Further spray trials are therefore contemplated using Maneb for the early applications, changing to Bordeaux mixture later in the season when the copper spray is likely to be less injurious.

Potato late blight: In further spray trials with summer crops no improvement in the control of late blight was obtained by adding a proprietary sticker to mixtures containing 0.2 per cent. zineb and 0.3 per cent. copper oxychloride. With both fungicides, however, better control of the disease was obtained when both leaf surfaces were sprayed.

(Report of the Secretary to the Federal Ministry of Agriculture, for the year ended 30th September, 1958.)

SARAWAK

Malaria control: The malaria control scheme, started in 1956, covered the whole country during 1958. Except for the occasional accident or breakdown of arrangements there is now no transmission of malaria. Steps towards Borneo-wide eradication are now being taken.

The World Health Organisation has voted 150,000 dollars (U.S.) for three years (1961-3) to assist Sarawak to convert from control to eradication with surveillance.

(Annual Report of the Medical Dept. for the Year 1958.)

Rubber Pests: It is reported that as the planted acreage increased so did the calls for assistance to combat the incidence of pests and diseases of which the most common were white ants, mites, aphids, snails, and Fomes lignosus, and Corticium salmonicolor (pink disease) respectively. To overcome transport difficulties and also to avoid unnecessary confusion in the minds of farmers, standardisation of materials used is practised wherever possible. Thus preference is given to a standard brand of fungicide which can be used at different strengths for the treatment of a number of diseases. It is also borne in mind that the average farmer is not able to mix complicated formulations and therefore directions for mixing and the quantities to be used are given in terms of those utensils which are in common use, e.g. chinese spoon (sudu), a cigarette tin or a four-gallon kerosene tin.

(Annual Report of the Department of Agriculture for the Year 1958.)

SEYCHELLES

Melittomma insulare control: "The (Melittomma) larvae have a sclerotised tailpiece with a serrated edge, and daily back down the tunnels pushing the accumulated chewed fibre residues and frass out of the entrance. At the same time the serrated edge of the tailpiece is used to enlarge the diameter of the tunnel. The mechanical damage caused by these tunnels is very slight but preceding and surrounding each of them is a zone of fermentation produced by micro-organisms associated with the larvae. These zones of fermentation around each larval tunnel gradually spread and coalesce, particularly in the softer, moister central part of the trunk which has relatively few vascular bundles. Once attacked by the micro-organisms, these fermented areas never recover and gradually degenerate into brown, then into black, rotten wood. Eventually an empty cavity is formed in the base of the trunk. When old palms with hard trunks are attacked, this cavity gradually enlarges and the peripheral ring of sound wood is so weakened by further infestation and spread of rot that the palm falls. This is a slow process and takes up to twenty years. In some cases it may be longer if, for example, there is no new basal infestation and free circulation of air in the hollow dries out the tissues and hinders the spread of rot. In the case of younger palms of up to 25 years old the boles are soft and sappy. When they are attacked the rot spreads rapidly and extensively. They then fall in about five years, before reaching the hollow stage.

The author recommends "that all further treatments for the control of Melittomma should be based on the following method:-

(1) Gouge the palm, removing all rotten black and brown wood and the worst of the fermenting areas so as to expose the larval tunnels.

(2) The day after gouging, paint the exposed surfaces with a recommended creosote/tar mixture.

(3) One week later, retar the palm giving particular care to any residual infestations.

(4) One month later, recheck and retreat any persistent residual infestations.

(5) One year later, recheck to ensure that no superficial infestations have developed."

A 5-years control scheme for Mahe and other infested islands is proposed. The cost is estimated at £86,000.

(Report on The control of Melittomma insulare Fairm. (Coleoptera, Lymexylonidae) attacking coconut palms in Seychelles by I.W.B. Nye, Ph.D., D.I.C., Commonwealth Institute of Entomology.)

SIERRA LEONE

Cacao

Amazonian cacao seedlings, propagated at Njala from selected strains obtained from West African Cocoa Research Institute, were planted out at Kpuabu. This cacao looked very promising, established at 99 per cent. and growth was satisfactory up to the onset of the dry season, shortly after which some 25 per cent. of the trees were attacked by a stem borer (probably Xyleborus morstatti Hag). Some 10 seedlings died, and 30 seedlings were cut back; the remaining seedlings are recovering and the insect attack appears to have been checked by painting the stems and main branches with a solution of DDT. It is proposed to investigate the use of other insecticides, mainly BHC in this problem.

Black pod disease: The highest incidence recorded of "black pod" disease, (Phytophthora palmivora Butler) in farms in Nongowa, Guara and Tunkia Chiefdoms was at Magbema (Guara), where 20 per cent. of the trees had an average of three diseased pods each.

Experimental work on this disease was continued at Kpuabu in Gaura Chiefdom during the season May-November. The trials were:-

I. Control (untreated) v. S.V.* and 1% Carbide Bordeaux applied at 1, 2, 3 and 4-weekly intervals.

II. Control v. S.V.* and 0.4% "Perepod" applied at 2 -weekly intervals v. S.V. and 1% Carbide Bordeaux applied at 2-weekly intervals.

III. Control v. S.V.* and 0.4% Kopapod (Blitox Ipsilon) applied at 2-weekly intervals v. 1% Carbide Bordeaux applied at two-weekly intervals.

IV. Control v. S.V.*

* S.V. = Sanitation and Ventilation i.e. brushing and removal of diseased pods.

Results indicated that 1 per cent. Carbide Bordeaux mixture generally suppressed black pod disease in all treatments and was more effective than either Perepod or Kopapod.

(Report of the Department of Agriculture, 1957.)

SWAZILAND

Malaria: The malaria position continues to be satisfactory.

As a result of the success obtained in interrupting malaria transmission through the Territory by hut-spraying with residual insecticides (B.H.C. 50% wettable powder with 10% gamma content), control measures in 1957 were discontinued over a further area, and were maintained only in a "cordon sanitaire" approximately 15 miles wide, along the northern, eastern and southern borders, where 44,287 huts were sprayed, as against approximately 150,000 when all malarious areas were controlled.

The areas in which control has been discontinued, amounting to approximately two-thirds of all the malarious area of the Territory, were covered by surveillance teams, who were required to report on mosquito breeding, and to submit for examination blood slides, taken by the random sampling method.

Of the 6,798 blood smears from all areas examined during the year, malaria parasites were present in 64, and of these cases, 36 were recent arrivals from neighbouring territories, or Swazis who had recently visited neighbouring territories.

In the pre-control era, between 4,000 and 7,000 cases of malaria were reported yearly, and there were thousands of unreported cases. The parasite rate among the younger children during the transmission season sometimes reached 100% and in the winter months was often 50-60%.

Breeding by Anopheles gambiae continued in both controlled and uncontrolled areas, but even in areas where control had been abandoned for 2 years, it was not possible to find adult mosquitos in dwellings. The remarkable change in the habits of A. gambiae from its pre-control anthropophagic endophilic behaviour to its present exophilic and presumably zoophilic existence is not understood. The W.H.O. Anopheles gambiae Advisory Team is expected to visit Swaziland in February 1958 to investigate and advise on this and other vector problems.

(Report for the Year, 1957.)

UGANDA

Malaria: Plans were evolved between the Medical Department, the World Health Organization and the Kigezi Local Government for a campaign to begin early in 1959. The active phase of this campaign will last for two or three years and will aim to break completely the chain of malaria transmission.

Simulium control: A survey was undertaken of the areas in Lango and Acholi infested with S. damnosum arising from the 50-odd miles of rapids on the Nile between Atura Ferry and the Murchison Falls. The survey was a preliminary to a large-scale eradication scheme planned to take place in the early part of 1959.

(Annual Report of the Medical Department for the Year ended 31st December, 1958. Vol. 1).

Cereals: An experiment on stalk borer control was laid down at Serere on second rains sorghum. Previous work had indicated that cereal stem borers were not a serious problem in Uganda, but an experiment at Serere in 1956 showed that, in spite of apparently poor borer control, 1 per cent. D.D.T. dust had given considerably higher yields than other treatments, including control. The 1958 trial compared a few treatments with several replicates, the treatments being 1 per cent. D.D.T. dust at 5 x 1 week intervals; 2 per cent. dust at five and three times fortnightly intervals and an untreated control. All treatments gave a good degree of control of stalk borer, which persisted long after treatments ceased, but there were no differences in yield. This confirms the survey result that sorghum stalk borers are of little economic significance, and apart from minor work of more academic interest, that will be pursued as opportunity offers, the subject will be dropped from the section programme.

Coffee: The exceptionally high incidence of berry borer, Antestia and lace bug greatly reduced the prospects of obtaining a good crop. Picking of the main crop started at the lower altitudes in June. Owing to pre-occupation with circumcision ceremonies much of the crop was allowed to become over-ripe before picking, and quality suffered.

Fundamental to any study of the biology and control of an insect, is an adequate population sampling procedure. It is, unfortunately, true that for most coffee pests such information is lacking. Considerable effort, in co-operation with the Coffee Research Unit, has been devoted to providing such an estimate for Antestiopsis and berry borer on Arabica coffee, with some success in the case of the former pest only. Analysis of many previous Antestiopsis test-spray results revealed that they would not fit any known distribution; this, combined with the great gaps in our knowledge of Antestiopsis population structure in general, suggested very strongly that the test-spray system elaborated in other territories might be inaccurate. Investigations have shown that a systematic sample, of either a fixed number of trees, or a fixed percentage of trees, taken across a diagonal produce a population frequency distribution curve that is negatively skewed, the amount of skew depending on the general level of populations involved; a skew-normal distribution is good evidence that the sampling technique adopted is at least a considerable improvement upon the previous techniques. Concurrently, investigations have been made into the efficiency of various test-spray insecticides and into various other minor matters of general technique. A standard sampling procedure, based upon ten trees taken across a diagonal, can now be recommended, of which the errors of sampling and recovery are known. The work is being written up.

Extremely good control of Antestiopsis by malathion has been obtained in work in Ankole and Toro districts; for these areas two pints of a 50 per cent. concentrate per acre would appear adequate. There is, however, little doubt that if pruning was timed immediately to precede spraying, one pint per acre would suffice: investigations are pending on this aspect.

A pilot scheme using spray teams was carried out in the Ibanda area of Ankole in March. One hundred and eighty acres of coffee were sprayed at a cost which varied according to the type of sprayer used, of between Shs. 30 and Shs. 40 per acre. Excellent control was obtained which has continued to date. Although yield figures could not be obtained, the out-turn from dried cherry from the area increased by 6 to 9 per cent. An estimate of the number of beans damaged by Antestia showed a drop from 39 to 17 per cent.

On Mount Elgon, Antestiopsis has been controlled by a D.D.T. malathion mixture, but in view of the dangers involved in the use of D.D.T. on coffee, work is in progress on the evaluation of malathion alone.

There is evidence from previous trials that berry borer can be controlled by lindane and dieldrin. However, it has become apparent that the successful conduct of spray trials against this pest depends in no small measure upon a satisfactory sampling technique. Spray trials have therefore been suspended while this is investigated.

Cotton: Two major spraying experiments have been conducted at Serere. In both, the insecticide was D.D.T. at 1 lb. per acre. A repeat of the 1957 time of commencement trial largely confirmed the previous results. There were no significant differences between the yields on spraying at 35-, 55- or 75-days from germination, but all were highly significantly better than the unsprayed control: in terms of yield per acre the difference was about 600 lb. seed cotton. An analysis of clean and dirty cotton showed that the control and 35-day treatments had more dirty cotton than the 55- and 75-day treatments, which would indicate that the two latter treatments are best. However, in 1957, the 75-day treatment yielded no more than the control, probably due to a dry September: in general, therefore, the experiment confirms the present recommended practice of starting spraying at eight weeks from germination.

The second experiment was designed to test the effectiveness of reduced spray coverage; applications were four at ten-day intervals; three at 15 days; two at 20 days, and an unsprayed control, all treatments commencing at eight weeks from germination. Final yields of total cotton showed significant differences:-

Treatment	Yield (lb./acre) Mean	L.D.S. @ 5%
4x	801	164
3x	691	-
2x	401	-
0	208	-

Differences significant at P = 0.001

The yield differences show a strong relationship to leaf damage counts, which revealed significant treatment differences, and to shed counts, which did not reveal significant differences. A repeat of this trial will be laid down in 1959.

A heavy attack by tea mite (Hemitarsonemus latus) on Serere cotton afforded an opportunity to check visual observations that D.D.T. controlled this mite. Counts made on the frequency of application experiment showed, however, that varying numbers of applications of D.D.T. had no significant effect upon mite populations, either way, neither could major differences be found in fruiting point counts on attacked and unattacked plants. It thus appears that, on the evidence so far, tea mite has little effect on the cotton plant, and D.D.T. within the range of applications tried, neither increases nor decreases the population.

Stored products: Work on the control of bruchids in grain legumes is nearing successful completion, as also are investigations into control of maize pests in cribs of simple design. In both cases control is based upon lindane dusting; this work is being written up, and a departmental instruction sheet will shortly be prepared.

An extremely successful fumigation of maize at the Jinja Grain Storage Plant was done with Phostoxin, an aluminium phosphide fumigant. A high degree of control was achieved, and it would appear that this product has a considerable future for bulk fumigation, under suitable conditions.

(Annual Report of the Department of Agriculture, for the Year ended 31st December, 1958.)

Forestry

Termite attack in eucalyptus planting: Experimental results continue to be either baffling or inconclusive. At Gulu the untreated controls showed most survival, while at Moroto the reverse was true but trees given simply a pint of water at planting time seemed to be almost as well off as those with insecticide. A considerably expanded programme of experiments has been prepared for 1959.

Gall on Chlorophora: The Nakawa experimental plot developed galls during its seventh and eighth month and by 12 months 95 per cent. of the trees were attacked. Four spraying treatments were applied, using dieldrin, BHC, malathion and Rogor. Results should be conclusive by the middle of 1959.

Borers in felled trees: Two series of tests were completed on Bosqueia and Antiaris, using dieldrin and BHC in two proprietary formulations. Assuming that the logs are left only four to six weeks in the forest both chemicals were effective, but the low toxicity and cheapness of the BHC make it more suitable for general use. A technical note for distribution to sawmillers is being produced.

(Annual Report of the Forest Department, Uganda, for the Year ended 31st December, 1958.)

TANGANYIKA

Malaria: Mosquito control work continued to be based primarily on drainage and larvicides, the latter consisting of weekly oiling with high spreading malariol containing 5 per cent. DDT or dusting with BHC formulations. The efficacy of these measures was routinely assessed at most stations by weekly adult anopheline catching in pyrethrum sprayed houses. Imagocidal treatments, using residually acting dieldrin, were carried out at Mpanda, Mtwara, Kitangare, Marvera, at various institutions and at Ukonga international airport, Dar es Salaam.

At Mpanda minor settlement the attempt at malaria control by residual spraying to which reference was made in the previous year's report was continued throughout the year and the results obtained indicate that, in the conditions at Mpanda, anopheline control by this method was much more effective than was larviciding and dam clearance. There was a very substantial diminution in the catches both of Anopheles gambiae and of A. funestus and there was an appreciable decrease in the parasite rates, particularly amongst the young children. As happens with residual spraying, the nuisance caused by culicine mosquitoes increased and this led the population to entertain doubts as to the value of the spraying operations. In an endeavour to offset this, larviciding of domestic culicine breeding places was intensified.

At Mtwara in the Southern Province where local conditions give rise to drainage and larviciding problems, malaria control by residual spraying was also attempted. In March all housing in the town was sprayed with 50 per cent. water-dispersible dieldrin and routine mosquito catches were continued for the remainder of the year. Findings have, however, been inconclusive so far but it is the intention to continue with this experiment in the coming year. Residual spraying was also continued at the Rift Valley settlement of Mto-wa-Mbu and a very substantial reduction in the numbers of anopheline vectors was achieved for at least 9 months following a single spraying with dieldrin-resins. The vector anopheline incidence remained low but once again on account of the increased prevalence of culicine mosquitoes the local inhabitants had no faith in the spraying operations and were opposed to their repetition.

Schistosomiasis: The view is strengthening that this infestation is one of the more important public health problems in the territory. In fact the opinion has been expressed that it is the principal single public health problem in all areas immediately to the south-east of Lake Victoria. There is also definite suspicion that the infection is established on the western side of the lake which was in the past considered to be clear. There is no doubt that the many water conservation schemes being developed are adding to the schistosomiasis problem. No methods of control of practical application in the general circumstances obtaining in the rural areas of Tanganyika have so far been devised, but in certain local areas where circumstances were favourable efforts at control were made. Such an attempt was made on a large sugar estate at Arusha Chini in the Moshi District with a fair measure of success, but it is clear that investigation is very necessary to provide the knowledge required for a reasoned attack on this problem.

(Annual Report of the Medical Department, 1958, Vol. 1.)

Forestry

The mvule gall insect (*Phytolyma lata*) was again successfully controlled at Longuza, Muheza, with a five per cent. application of "Dieldrex 15", at monthly intervals during the rains. It was found, however, that, on an average, the treated trees grew no better than the untreated; indeed, there were indications that "Dieldrex" tended to suppress growth.

Further consignments of the predatory snail *Gonaxis kibweziensis* to control the destructive snail *Achatina*, were received from the Kenya Forest Department, but only nine survived out of fifty. Meanwhile revised silvicultural practice with mvule, emphasizing clean weeding and canopy removal, reduced the tendency for *Achatina* to build up to epidemic proportions. Millipedes in the Tanga nursery were controlled with Agrocide No. 10.

Marine borers: Martesia striata was the commonest and most vigorous wood-boring mollusc. No timber was resistant and only preservatives with heavy concentrations of copper, proved satisfactory - even creosoted timber was attacked. Teredinidae continued to do severe damage to timber and only heavy and deep concentrations of copper controlled this group. Limnoria caused severe damage at "wind and water" level, notably to Douglas fir.

(Annual Report of the Forest Department for the year ended 31st December, 1959.)

PROPRIETARY DATA

ASSOCIATED FUMIGATORS LIMITED

Messrs. Associated Fumigators Ltd., manufacturers of the well-known series of fluoroacetamide pesticides including 'TRITOX' and 'MEGATOX' announce the formation of a Research and Development Department, to be directed by their technical staff in co-operation with their Consultants, M. A. Phillips and Associates, Ltd.

The new department will deal, amongst other things, with fundamental research on residue analysis in plants, wetting problems for agricultural sprays, etc. and with commercial developments based on new compounds derived from fluoroacetamide and fluoroacetanilides and also on mercurial and non-mercurial fungicides.

In the new laboratories now being erected, it is also hoped to commence work on nematocides, with special reference to systemic nematocides.

CYANAMID OF GREAT BRITAIN LTD.

Agricultural Division, Bush House, London, W.C.2.

The following literature has been received.

Malathion Animal and Poultry Guide (folder)
" Grower's Guide (folder)
" Health and Household Guide (folder)
Malathion 60 (brochure).

EKATIN

Sandoz Ltd. Basle, Switzerland.

Selective systemic insecticide and acaricide with thiometon ∅ as active ingredient recommended for the control of aphids, jassids (*Empoasca*) and red spider (*Tetranychus* sp.)

Sprays are prepared by mixing the requisite quantity of Ekatin with water at the rate of 16 fl.oz Ekatin per 100 gal water to give a standard concentration of 0.1%.

Application

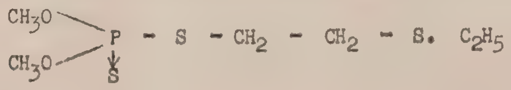
Hops - For hops soil treatment has proved most successful. Pour approximately 2 pints of the diluted Ekatin around the base of the plant as when watering.

Viticulture - Spray between bursting stage and blossom according to weather conditions, usually when the young shoots are from 2 to 4 inches long.

Fruit trees - Spray immediately after blossom.

Ekatin shows an increasing effectiveness during 4-6 days after application, persisting for 8-10 days and fading quickly after the end of the protection period of 2-3 weeks. Thiometon loses its effectiveness through decomposition and excretion by the plants.

∅ (O,O-dimethyl S-ethylthioethyl phosphorothiolothionate)



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ETHION

Niagara Chemical Division, Food Machinery and Chemical Corporation, Middleport, New York.

Ethion, classified as an insecticide/miticide is based on 0,0,0',0'-tetraethyl S,S'-methylene bisphosphorodithioate. Ethion has been approved as the common name for this compound by the American Standards Association. The technical chemical is an essentially nonvolatile liquid which solidifies in the range of -12°C to - 15°C. It is soluble in most organic solvents including xylene, acetone and methylated naphthalenes. It is also soluble in the aliphatic hydrocarbons including kerosene and dormant and summer insecticidal oils. It is virtually insoluble in water.

Uses

Ethion has been tested under a variety of field conditions for more than 3 years with the result that its potential use pattern is becoming rather clearly defined. The most likely area of use is for the control of foliage mites on cotton, seed alfalfa, deciduous fruits and quite possibly citrus fruits. Ethion in combination with oil is effective in early-season (pre-bloom) treatments for the control of the rosy apple aphid, eye-spotted bud moth, mites and scale insects. Post-bloom treatments have been very promising for the control of the foliage mites, codling moth and apple maggot. In the vegetable area, ethion is effective for the control of Mexican bean beetle, serpentine leaf miner, pickleworm, leafhoppers and certain of the root and seed infesting maggots.

Formulation

Ethion will be made available to cooperators in the following formulations:

(a) 25% wettable powder (WP 25) for foliage treatments.
(b) 50% wettable powder (WP 50) for seed treatments.
(c) Emulsifiable concentrate containing four pounds of active ingredient per gallon (EC 4).
(d) Emulsifiable concentrate containing four pounds of active ingredient per gallon and a reduced amount of emulsifying agent (LEC 4) (Available only from Richmond, California facility).
(e) 4% dust (D 4)
(f) 5% and 8% granular (G 5 and G 8)
(g) Ethion emulsifiable oil (containing 2% ethion and 95% insecticidal oil for use at delayed-dormant period) (EO).

Toxicology

Extensive toxicological studies have been carried out. For example, the acute oral LD50 of technical grade ethion administered in corn oil by stomach tube, for male albino rats has been determined to be in the range of 96 mg/kg body weight with confidence limits of 86 to 107. Ethion formulated as WP 25 or as EC 4 has been found to have acute oral LD50 values of 140 mg/kg and 108 mg/kg body weight, respectively. The acute oral LD50 of purified ethion determined by the same method is 208 mg/kg body weight with confidence limits from 128 to 340. These values place the compound in the moderately toxic class when administered orally.

Additional Reading

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Berton C. Dickinson, Niagara Chemical Division, Middleport, N.Y.
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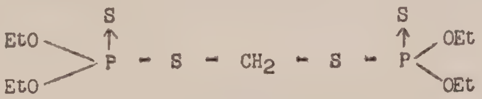


ethion

GLYOXIDE

Corona Chemical Division, Pittsburgh Plate Glass Co., Moorestown, New Jersey.

Corona 'Glyoxide', free base of 2-heptadecyl glyoxalidine, is the active ingredient (70% w/w) of "Corona Glyoxide Dry" micronised ^{C} wettable powder. This product is intended for use as a protective fungicide against apple scab and sour cherry leaf spot. *

Compatibility

Glyoxide is compatible with DDT, methoxychlor, Aramite, wettable sulphur, ferbam, dichlone, hydrated lime and with wettable powder formulations of DDT and TDE, parathion, malathion, dieldrin and benzene hexachloride.

Mixtures with summer oils or with liquid formulations of DDT and TDE, parathion, malathion, dieldrin, or benzene hexachloride may be injurious to foliage and fruit. It is necessary to safen lead arsenate when used with Glyoxide - (Ferbam ½ lb per 100 gal or an amount of spray grade hydrated lime equal to the weight of the lead arsenate will act as a safener).

Apple Scab Control

Apply 2/3 lb per 100 gal of spray (1) at delayed dormant when fruit buds show green; (2) at pre-pink; (3) when blossom buds show pink; and (4) at petal fall.

Glyoxide suppresses European red mites and a miticide may not be required when this fungicide is used in a complete spray programme. Glyoxide also aids in suppressing light infestations of two-spotted mites during that part of the spray programme when the fungicide is used.

Note: For after-rain control of scab the addition of Coromerc (¼ lb) or Phygon XL (¼ lb) to Glyoxide (½ lb) in each 100 U.S. gal spray is recommended.

Sour Cherry Leaf Spot Control

Use ½ to 2/3 lb of Glyoxide per 100 gal of finished spray (1) at petal-fall; (2) at shuck fall; (3) at first pre-harvest (first fruit fly); (4) at second pre-harvest (or final fruit fly).

NEW SPRAYING UNIT FOR AIRCRAFT

A new application for Shell Thermoplastics has recently been developed by Shell Chemical Company Limited. An aerial spraying unit is now being manufactured (by Rediweld Limited, Crawley, England) in which the nozzles of the equipment are made from Shell 'Carlona' polypropylene. The saving in weight over the brass nozzles previously used is sufficient to enable spraying aircraft to carry an extra two gallons of insecticide, thereby extending the spraying run by 150 yards. It has been reported that one of these units has been used successfully for several months now in South Africa.

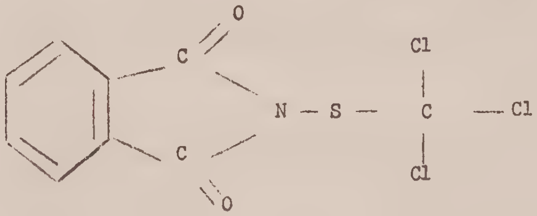
(Shell Aviation News, November, 1959, No. 257, p.24).

* Notes: (1) Spreader stickers are not recommended for use with "'Glyoxide'.
(2) 'Glyodin', a liquid formulation, contains 2 heptadecylglyoxalidine acetate dissolved in isopropanol.

PHALTAN

California Spray-Chemical Corporation.

'Phaltan' is registered trademark of California Spray Corporation for N-trichloromethylthiophthalimide fungicide. It is a white (pure), non-volatile compound, insoluble in water and very slightly soluble in organic solvents. It is completely stable when dry but is subject to hydrolysis particularly at high temperatures and in strongly alkaline media.



Uses

Following five years of extensive field testing the compound has been registered in several countries for the following uses.

Citrus: melanose and scab.
Potatoes: early and late blight.
Sour cherries: leafspot.
Grapes: deadarm, black rot, downy mildew, powdery mildew.
Cranberries: fruit rots.
Ornamentals: apply as required.

Toxicology

In acute oral studies on male albino rats, all animals survived at the highest dosage tested for Phaltan of 10 gm/kg of body weight. In sub-acute studies, Pahltan added to the diet of male and female rats for 12 weeks at 1000, 3200 and 10,000 p.p.m. resulted in no deaths and no abnormalities found upon microscopic examination of the organs. There was only a slight reduction in body weight gains in the 10,000 p.p.m. males.

Precautions: Dust may be irritating to mucous membranes. The same precautions should be observed as are customary for handling captan.

Phytotoxicity

Ortho Phaltan products have shown a wide range of plant safety similar to Orthocide products containing captan. Some injury has been noticed from applications on d'Anjou pears. Under conditions of high temperature and humidity, excessive dosages may injure some varieties of grapes and seedling cucumbers. Defoliation and/or shot-holing from early and mid-season application on peaches and sweet cherries may occur. The finish of some apple varieties may be impaired due to application during the period of four weeks following bloom. It appears, however, that practical, safe schedules may be developed.

Research Suggestions

Preliminary data indicates that fruitful research with Phaltan products may be accomplished in the following areas:

Diseases and storage rots affecting small fruits
Seed treatment of vegetables and field crop seed
Soil and furrow treatment of cotton, beans and other crops applied at planting time
Post-emergence control of damp-off in various ornamental and crop plant seed beds
Fruit and foliage diseases attacking tree fruits and leafy vegetables
Powdery mildew control of many ornamentals, flower bulb disinfection and protection, use in cutting dips in combination with rooting hormones, turf diseases, and root rot control on ornamental plants.

It is customarily formulated as a 50% wettable powder. A typical application is 2 lb Phaltan 50 W per 100 U.S. gallons spray.

Results of trials comparing Phaltan with Orthocide (captan) and other fungicides are obtainable from the manufacturer.

PHOSTOXIN

Degesch, Frankfurt am Main, Western Germany.
U.K. Agents, The London Fumigation Co. Ltd., Marlow House, Lloyds Avenue, London, E.C.3.

This grain fumigant material is mainly composed of pure, finely ground aluminium phosphide which, on contact with moisture, generates phosphine. It is available in tablet form, each tablet weighing approximately 3 g and releasing 1 g phosphine.

Toxicology

After release of the phosphine a fine grey-white powder remains, said to be composed of non-poisonous hydrated alumina together with a slight trace of aluminium phosphide (less than 1% of the original tablet weight), which decomposes almost completely when the grain is moved. Aspiration is stated to remove entirely this dust contamination.

Uses

Fumigation of grain stored in granaries, dumps, simple silo bins, earthen pits, box cars and bags. Tablets may be dropped by hand into the grain stream whilst loading or by means of special probe. The number of tablets required per short ton (907.2 kg) normally ranges from 4-10. Under favourable storage conditions up to 15 tablets may be required.

Phostoxin is claimed to be effective against the adults, eggs, larvae and pupae of all types of grain insects e.g.:

Grain weevil (Sitophilus granarius or Calandra granaria)
Rice weevil (Sitophilus oryzae or Calandra oryzae)
Saw-toothed grain beetle (Oryzaephilus surinamensis)
Flat grain beetle, rusty grain beetle (Cryptolestes or Laemophloeus spp.)
Khapra beetle (Trogoderma granarium Ev.)
Lesser grain borer (Rhizopertha dominica)
Rust-red flour beetle, etc. (Tribolium spp.)
Cadelle (Tenebroides mauritanicus)
Grain moth (Nemapogon granella or Tinea granella)
Dried fruit moth (Plodia interpunctella)
Mediterranean flour moth (Anagasta kuehniella or Ephestia kuehniella)
Angoumois grain moth (Sitotroga cerealella).

It is also effective against mice and rats.

In addition Phostoxin will control the migratory stages of mites such as

Flour mite (Acarus siro or Tyroglyphus farinae)
Mushroom mite (Tyrophagus dimidiatus)
House mite (Glycyphagus domesticus)

TINTOMETER LTD.

The Colour Laboratory, Salisbury, England,

Literature issued by this firm testifies to the highly skilled and diverse applications of colorimetry to assist industrial and research requirements.

Measurements are based on the Lovibond scale, developed by a brewer, a century ago, who wished to standardise the colour of his beer. Lovibond also made the prototype tintometer - out of a black tea-caddy in which were cut two slots - one for a liquid of standard colour and the other a specimen of beer for matching.

The full Lovibond scale now comprises over 200 steps in each of red, yellow and blue, giving a range of nearly nine million possible combinations. It is accepted as standard by 40 countries.

The firm has recently, in conjunction with other organisations, developed field kits for (1) determining minute quantities of pentachlorophenates, and (2) cholinesterase tests on the blood of users of organo-phosphorus insecticides:

Colorimetry - Part I.
Colour and the Visual Measurement of Colour.
Colour Measurement in Science, Industry, Agriculture and Medicine.
The Visual Measurement of Colour by Means of the Lovibond Colour Scale.
Lovibond Compactor Kits for Testing the Water in Public Swimming Baths.
B.T.L. Test-Kit for Pentachlorophenates.
Blood Tests for Users of O.P. Insecticides.

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PESTICIDES

INSECTICIDES
E. B. Brown. M.A.F.F., Tech.E 6,(N.A.A.S. Tech.67). Revised 1959.

Concise, general information in brochure form. Three sections:

I. Introduction
II. Insecticides (arranged alphabetically).
III. Prices (a useful price summary of various insecticidal formulations.)

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2. The relationship between level of application (50-1000 p.p.m.) and duration of activity (lasting 0-50 days) was demonstrated using captan activity as an example. The smaller the quentity of fungicide incorporated into the soil, the earlier was the decrease in activity, measured by successful disease control.

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1 kg chlorinated carbolic oil was sprayed in 10% soln. over two areas of wet pasture, each 1,000 sq. metres. When snails were collected 4 weeks later, 7 out of 121 snails were found to be alive on one of the treated areas and 14 out of 76 snails were found to be alive on the other. In the untreated neighbouring areas about half of the snails were found to be alive.

These results, suggest that chlorinated carbolic oil has the same efficiency against snails as copper sulphate. It is considerably cheaper and could be used instead of copper sulphate."

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> The grill is placed at the centre of fly concentration and the count is made within 30 seconds. In a house, the counts are made at 6 places, 3 indoors and 3 outdoors. The mean of 2 maxima out of 6 counts is considered as the fly index of that house. The mean of 3 maximum indices out of all houses in a certain village containing from about 6 to 15 houses under examination is considered as the fly index of that village. This method of using fly grill has been proved experimentally the most applicable for evaluating housefly control."

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ABSTRACTS

COLONIAL PESTICIDES RESEARCH UNIT, PORTON.

HALF-YEARLY PROGRESS REPORT, 1st APRIL-30th SEPTEMBER, 1959.

CPRU/Porton/Report No. 165.

The toxicity of some organo-phosphorus componnds to mosquitoes and houseflies

Details were given in CPRU/Porton/Report No. 164 - See PANS, (A), 1959, 5, (4) p. 515.

Chlorthion, malathion, diazinon, isochlorthion, Rogor, Resitox, Gusathion and Dow ET-57 were all sufficiently toxic to mosquitoes to warrant further investigations on their residual properties.

The residual properties of some organo-phosphorus compounds on building materials

The initial and residual toxicities of deposits of formulations of the most promising of the above compounds were investigated. Blood-fed female Anopheles stephensi were exposed for varying periods on deposits containing 100 mg active ingredient per sq. ft on plywood panels and on dried mud bricks.

Rogor is a liquid with a solubility of about 3% in water, and no wettable powder of this compound is available. An emulsion was therefore used, and, as expected, deposits on an impermeable surface such as glass were highly toxic, but deposits on plywood and dried mud were ineffective.

Wettable powders of the other compounds were used. On plywood panels, malathion was the most promising, losing little of its effectiveness after 10 weeks. Diazinon was highly toxic initially but rapidly lost its effectiveness after 2 weeks, while DOW ET-57 lost its effectiveness after 4 weeks. On dried mud bricks, these compounds were either ineffective or had only a short residual life.

Although solutions of Gusathion and Resitox applied topically were highly toxic to mosquitoes, deposits from wettable powders on both plywood panels and dried mud bricks were, surprisingly, ineffective.

Investigations have been carried out to measure losses by evaporation, absorption, adsorption and decomposition in an attempt to explain the biological results and with a view to obtaining improved and effective formulations of organo-phosphorus insecticides.

Decomposition: Rates of decomposition vary greatly on different soils but examination of a wide range of soil types has so far given no definite clues as to the soil properties which are important in this connection. There is only the empirical observation that the adsorptive, lateritic soils previously found active in adsorbing insecticides are also the most efficient catalysts of decomposition.

The behaviour of insecticides other than those mentioned in previous reports has also been investigated on the standard Uganda soil. Gusathion and Resitox are decomposed much less rapidly than the other compounds tested and on this account should be satisfactory residual insecticides, especially as they also have low volatilities and are relatively resistant to sorption. Unfortunately, as mentioned above, they have proved to be ineffective against mosquitoes when used as surface deposits from wettable powders.

It has been reported that the residual life of diazinon is prolonged when mixed with DDT and it was therefore of interest to see if the rate of decomposition of diazinon could be reduced by this means. Diazinon, in fact, decomposed at its normal rate on Uganda soil when an equal quantity of DDT was present.

A factor which may be of importance in the decomposition of organophosphorus compounds on soils is the presence of metal ions with catalytic properties. Impregnation of the Uganda soil with EDTA, a chelating agent used for the purpose of removing catalytically active ions from solution, only reduced the rate of decomposition of diazinon very slightly.

Distribution of insecticides on freshly-sprayed surfaces: Wettable powder formulations of liquid insecticides give much poorer biological effects on porous surfaces than on non-porous ones. This is likely to be because these powders usually form emulsions of the insecticide when dispersed in water and these soak in to the porous substrates, giving a smaller surface deposit than would a dispersion of a solid insecticide which is filtered off at the surface. Measurements of the amounts of liquid insecticides left with the solid carrier of the wettable powder on a porous surface have now shown that they can be less than 2 per cent of the nominal dosage sprayed. This can be compared with the high recoveries of more than 90 per cent obtained with solid insecticides on the same surface. This behaviour of liquid insecticides is therefore quite adequate to explain their low effectiveness on such surfaces.

The sorption of solid organo-phosphorus compounds: The organophosphorus insecticides which are solids at room temperature might be expected to behave in the same way as chlorinated hydrocarbon insecticides on surfaces made of active soils with strong adsorptive properties. That is, the solid particles would disappear but the insecticide would subsequently be recoverable from the soil. However, as it is already known that such soils are also good catalysts for the decomposition of organo-phosphorus compounds, this process might go on at the same time or subsequent to sorption.

Dispersions of the pure insecticides were made in wetting-agent solutions and sprayed onto Uganda mud blocks. DDT and dieldrin suspensions were sprayed at the same time for comparison. Isochlorthion and Dow-ET-57 deposits disappeared more rapidly than the two chlorinated hydrocarbons but Gusathion and Resitox were much more resistant to sorption. When the Resitox deposits did begin to disappear after several weeks the rate was greater at high than at low humidity, in contrast to the behaviour of DDT and dieldrin. This was shown to be due to concurrent decomposition of Resitox being greater at high humidity and this was accompanied by accelerated diffusion of the decomposition products deeper into the soil.

Breeding of agricultural insects

Further sendings of the African maize stalk borer, *Busseola fusca* have been received but these are still insufficient to maintain a breeding colony as large numbers of those received were parasitized by *Apantales sesamiae*. An attempt is being made to obtain collections from another area.

Seed dressings

The preliminary experiments on the position of external deposits of insecticides applied in seed dressings, on germinating dwarf beans, have been repeated. After dipping the seeds in a suspension of fluorescent dye and planting one inch below the surface of fine soil, small quantities of dye were found to be carried up by the cotyledons, mostly on their outer side, on the first leaves and in some cases, on the stem. Until quantitative determinations can be carried out by chemical and radio-active means it is impossible to say whether enough insecticide would be carried up to give protection against the bean fly, *Melanagromyza phaseoli*.

Test methods for Lepidopterous larvae

Until completion of the spray tower, deposits have been applied to filter papers by a pipette, spirally; but at the low rates at which residual deposits are picked up, insufficiently high deposits of emulsion can be obtained on filter paper for an effect on larger larvae.

Up to 8 mg endrin per sq. cm have been applied. It is intended to use plant leaf surfaces as soon as a uniform deposit can be obtained.

Distribution of spray on a maize plant

It has been shown that spraying the stems of young maize is important in the field control of stalk borer, but that a deposit in the central whorl has the most effect. The distribution of spray pattern on maize plants, about 1½ feet high to the central whorl, was determined with croceine scarlet dye from a flat spray 00 nozzle at a constant pressure of 25 lb/sq. in. The height above the whorl was one foot, at which height the swathe width at the whorl was 2 feet. The delivery rate was 8 ml/second. The deposits, washed off with water, were estimated with an absorptiometer.

The following mean percentage deposition of spray was found:-

	Stem	Whorl	Leaves	% of total applied over 2 x 2 sq. ft
A.	1%	6%	93%	22%
B.	1%	29%	70%	32%

A: moving at a rate of just over one mile an hour.

B: stationary burst of one second over centre of plant, at the same height as A.

In each case the flat spray nozzle gave greater deposits on the leaves than in the central whorl, but the proportion deposited in the control whorl was greater in case B when a heavier spray was applied.

Survey of the use of stalk borer control methods

CPRU/Porton/Report No. 163 gives full details - See PANS, (A) 1959, 5, (4), p. 524.

Dispersion of molluscicides

Preliminary trials with glass frits containing copper have shown that adequate amounts of copper ions for snail control can dissolve into water from such a formulation. One difficulty is that the rate of solution depends upon the pH and carbon dioxide content of the water and is therefore likely to vary from one natural water to another. Much more work is clearly necessary before this method of application can be evaluated.

Physical studies on sprays

The recently appointed physicist has begun investigations by familiarising himself with assessment techniques and by calibrating the wind-tunnel in preparation for laboratory studies on the behaviour and deposition of spray drops.

Laboratory Workshop

A droplet applicator based on a design by Mr. Poulton of C.P.R.U., Arusha, and a Potter spraying tower have been made for the use of members of the Unit.

An air compressor and receiver unit (Bullows type 15 AR 701) has been installed and a temporary line rigged to operate a spinning top in the wind-tunnel. Work is in hand to instal permanent air lines to such points in the laboratory as are found desirable by experience during the next few months.

COLONIAL PESTICIDES RESEARCH UNIT, ARUSHA, TANGANYIKA

PROGRESS REPORT NO. 25, APRIL-SEPTEMBER, 1959.

INSECTICIDES

Tsetse - Field Experiments

(1) Chungai

A second series of aerosol applications is being made in Chungai in an attempt to obtain better control than was achieved in last year's unsuccessful experiment. The following important changes have been made:-

(a) A 2.5 per cent (w/v) solution of dieldrin is being used instead of a 5 per cent (w/v) solution of BHC.

(b) The volume dosage ($\frac{1}{8}$ gallon per acre) per application is $1\frac{1}{2}$ times that of the previous series.

(c) The swathe width has been reduced from 70 yd to 55 yd.

Three applications have been completed with promising results. For Glossina morsitans kills of old males have apparently been 95 per cent or better per application while the kills of old females are less reliably estimated at about 85 per cent; the catches of G. pallidipes have been small, but comparable kills have apparently been achieved.

(2) Kabiganda

The G. morsitans population in this valley, where dieldrin emulsion was discriminatively sprayed, has continued to fall.

The apparent density is now less than one per cent of the pre-treatment figure, having fallen during the past three months despite increases in the area generally.

The susceptibility of tsetse flies to insecticides

A susceptibility test, based on the WHO mosquito test kit, has been developed for adult tsetse flies. Ten flies are tested in each tube; exposure is for one hour, after which the flies are placed in uncontaminated tubes for twenty-four hours before measuring mortalities. Reliable results can be obtained if the flies are fed immediately before exposure.

Mosquitoes

Taveta-Pare malaria eradication scheme

This scheme came to an end on 30th June and an account of it is now being written for publication. Surveillance continues in the area and it is possible that further spraying will be carried out to endeavour to eliminate the low degree of parasitaemia still present in man.

Experimental house trials

The main work on the BHC treated houses at Magugu has been completed, but the efficiency of the different formulations is still being measured using wall exposure chambers. Insects are being exposed to the walls and to the thatch of the houses. The wall exposure chamber developed by this Unit has been compared with the WHO plastic dish and plastic funnel exposure chambers. All three chambers produce fully interchangeable results.

The first trials with the portable experimental house at Muheza have finished. It is now planned to extend the work to six mud and thatch huts.

The susceptibility of Anopheles gambiae to insecticides

The survey has been extended to the Kampala district. There was no sign of any decreased susceptibility of A. gambiae to DDT, gamma BHC, or dieldrin. Monthly visits have been made to the field station at Magugu and the susceptibility to insecticides of wind-caught A. gambiae has been measured over a period of six months. From the information available there does not appear to be any significant or regular change in susceptibility to insecticides. The range of median lethal concentrations recorded from this station are as follows; DDT, 0.58-1.2%; gamma BHC, 0.005-0.008%; and dieldrin, 0.053-0.081%.

The susceptibility of Aedes aegypti to insecticides

The investigation on the effect of temperature during the exposure period, on the susceptibility of Aedes aegypti is being continued to include a wider range of temperatures.

The exposure to dieldrin of adult A. aegypti under 24 hours old has now been carried out through nine successive generations. The slightly increased tolerance to dieldrin which first appeared in the second generation has not changed.

Other insects of medical importance

(1) The survey on the susceptibility of Cimex hemipterus to dieldrin is being continued at Magugu. The tests do not show any sign of a further increase in resistance.

(2) At the request of the World Health Organization, the susceptibility of Pediculus humanus corporis, collected from sprayed houses in the Pare-Taveta Malaria Control Scheme, has been assessed for DDT, gamma BHC, and pyrethrins, using the W.H.O. louse testing kit. It has not yet been possible to collect sufficient lice from untreated areas to obtain data for comparison.

Pseudotheraptus

The replicated small-plot trial has not been sprayed for two years and the crop resulting from the first year of protection has been harvested. The protected palms yielded approximately 40 per cent more nuts than the unsprayed controls. However, it is doubtful if this increased yield will be maintained; the sprayed palms, having borne a heavier crop, are now flowering at a lower rate than the controls. Furthermore, at the last harvest in August, 1958, the three sprayed plots produced only 707 ripe nuts compared with 1042 from the unsprayed control plots. It may be that protection from Pseudotheraptus will produce initially an appreciable increase in yield but that this is at the expense of the palm's food reserves and cannot be maintained. However one can make no real assessment until the trial has run a further year.

As mentioned in previous reports, the ground under these experimental plots has been clean-cultivated to facilitate the collection of fallen nuts and the effects of clean cultivation on yield have been measured by recording yields from adjacent uncleared plots also. The effect of clean cultivation became apparent after one year and since then the cleared plots, sprayed and unsprayed, have given consistently higher yields than the uncleared ones. The results are summarised briefly in the table below.

Total nuts harvested from 150 palms per treatment

	Cultivated not sprayed	Not cultivated Not sprayed	Cultivated sprayed	Not cultivated Not sprayed
1957-58	2450	3513	3307	3003
1958-59	7445	5421	10637	4810

The aircraft trial at Tanga has continued and has shown that good control of Pseudotheraptus can be obtained by double applications of 1 lb of DDT per acre at a 14 day interval every three months. There are no indications yet that this has resulted in any appreciable increase in yield.

Aircraft trials in Zanzibar have shown that a single application of DDT at 2 lb per acre, or a double application of BHC at $\frac{1}{4}$ lb per acre with a 14 day interval, will both give good control of Pseudotheraptus. The BHC is slightly more effective but neither is as good as two applications of DDT at 1 lb per acre with a 14 day interval.

Generally the Pseudotheraptus work to date raises considerable doubts as to the economic advantages likely to accrue from control of this pest but it does suggest that proper cultivation of the plantations might result in appreciable increases. A larger trial has been started in Zanzibar to examine this last point in more detail.

The total chlorine method of estimation for DDT surface deposits on coconuts has been found to be unsatisfactory because of interference by chlorides in the coconuts. The Schechter-Haller method, giving greater specificity, was used. Several methods for the removal of DDT residues from the surface of coconuts have been investigated, but further work will be necessary to establish a method giving adequate recovery.

Other agricultural pests

Cotton

Two field trials on cotton at Arusha are now being harvested. Preliminary indications are that Sevin and DDT at equal dosages give roughly equal control of *Heliothis* & *Earias*, and that although Metasystox gave better control of red spider (*Tetranychus* sp.) in the laboratory, Rogor at an equivalent dosage may give a higher yield of cotton in the field.

Persistence of parathion on coffee

Parathion was applied to young single-stem coffee trees by means of the Oxford Precision Sprayer, using the insecticide in the form of both wettable powder and emulsion at strengths of 0.02 and 0.04 per cent.

The first samples of leaves were taken as soon as the leaves were dry, and other samples 3 hours, 6 hours and 24 hours after spraying. The deposit of parathion was removed by extraction with light petroleum and the insecticide was then determined by the method of Averell and Norris, modified by Gunther and Blinn ("Analysis of Insecticides and Acaricides", Interscience Publishers, p.516 (1955)).

In all cases the rate of loss of deposit from the surface of the leaves could be represented by a regression equation of the form:

$$\log_{10} (x + 1) = a - b \log_{10} (t + 1)$$

where x = parathion residue in mg per square metre of leaf surface,

t = time in hours after spraying,

a = initial deposit of parathion,

and b = regression coefficient.

Thus a suspension containing 0.02% parathion gave an initial deposit of 6.32 mg parathion per square metre of leaf surface. After 3 hours, 51% of this initial deposit remained; after 6 hours, 30%; and after 24 hours, 12%.

Similar trials are being done with diazinon and the full results will be presented later.

Biting Fly Research

Laboratory Insecticide Studies

Using an "Agla" micrometer syringe modified by Mr. T. R. Jones of the Agricultural Research Station, Kawanda, topical applications of insecticides were made to adult Stomoxys calcitrans. This fly was found to be very susceptible to both DDT and BHC, the respective LD. 50's being 0.0156 and 0.00127 micrograms per fly. Other insecticides are now being investigated.

An attempt is being made to induce insecticide resistance in S. calcitrans by insecticidal treatment of the larval stages over several generations.

Field work

Political disturbances in Buganda have caused the closing of the Bukomero field station but information was received that the Stomoxys population in the 50 square miles, which had been practically eliminated by spraying one cattle boma with chlordane, (C.P.R.U. Annual Report 1958-59) remained low for about three months. A catch in the area about six months after the spraying showed that the numbers had returned to normal and the cattle boma was resprayed in September.

A new site for a field station has been found in the Koja peninsula, south east of Kampala.

FUNGICIDES

Persistence of a copper fungicide on coffee leaves

The frequent applications of copper to coffee trees (described in C.P.R.U. Progress Report, 24, 18 (1959)) are continuing. During the period from December, 1958, to August, 1959, leaf retention has risen from 32 to 75 per cent and the incidence of Hemileia has not exceeded one per cent.

One half of the plot has now been treated with a copper spray containing a sticker. The effect of this additive on the persistence of the deposit will be studied.

Leaves from the trial plot have been examined for copper within the leaf tissue. Leaves which had borne a surface deposit of ca. 50 mg copper per square metre were found to contain 30 p.p.m. copper. This is considerably higher than the figure of 12 p.p.m. found in leaves which had no history of copper spraying.

MOLLUSCICIDES

A trial of the molluscicide, Bayer 73, on the Nairobi river was described briefly in the Annual Report for 1958-59 and more fully in Miscellaneous Report No. 232. It was found possible to carry out chemical analyses of the treated water and the results correlated well with the biological data. Limnaea reappeared in the river about one month after treatment but no Bulinus or Biomphalaria were found for 2 to 3 months.

A larger scale trial of this new molluscicide was carried out in September on the Mwea Tebere irrigation scheme. The water intake was at the rate of 100 cusecs and this water was treated with Bayer 73 at the rate of 0.75 parts per million for eight hours. This dosage apparently killed most of the fish in the area. Results on the snail population are being collected.

MISCELLANEOUS

1. The Drift of Toxic Chemicals

Based upon Suttons simpler theory of atmospheric turbulence and extensions to it proposed by Gregory and Chamberlain, calculations have been made of the drift of chemicals released from a line source situated a few feet above the ground. Some of the results were incorporated in a paper presented to the International Agricultural Aviation conference held in England in September, and a more detailed report will be prepared as soon as possible. From the calculations, and from practical considerations, it appears that the drift hazard from aircraft applications is minimal if

(a) the aircraft flies as low as possible;

(b) emission of chemical into the wingtip vortices is minimal;

(c) high winds are avoided;

(d) as little as possible of the chemicals is contained in droplets 10-60 microns in diameter.

2. Drop spectra from rotary brushes fitted to the D.H. Beaver aircraft

A limited number of measurements have been made of the drop spectra produced by rotary brushes fitted to a D.H. Beaver aircraft. The liquid was the proprietary solvent Dutrex 3/Novasol in which approximately 0.75% (w/v) of Waxoline Red, an oil-soluble dye was dissolved. The aircraft was flown at 95 m.p.h., and the ground deposit was sampled with oxide-coated plates. The main results are given in the table below.

Trial	Spray Unit	Emission rate Per unit (gal/min)	Volume median diameter (microns)
1	3 x 10 in. brushes (bristle dia. 0.010 in.)	2.75	138
2	3 x 10 in. brushes (bristle dia. 0.010 in.)	9.0	215
3	3 x 8 in. brushes (bristle dia. 0.005 in.)	2.75	212
4	3 x 8 in. brushes (bristle dia. 0.005 in.)	9.0	245

Fuller details are given in C.P.R.U. Miscellaneous Report No. 235.

3. The pickup of insecticide by settled locusts

Because a locust is a solid body it collects more insecticide when there is a wind than does a flat horizontal surface with the same plan area. It is theoretically possible to calculate the dosages collected in this way, but it was considered desirable to make some field measurements. Locusts were simulated by glass cylinders 5 cm long and 1 cm in diameter, orientated with their long axis at right angles to the wind and placed both on the ground and at various heights above it. Sprays, with volume median diameters of 120-170 microns, were applied from an aircraft flying at right angles to the wind and at a height of about 30 ft.

The full details are given in C.P.R.U. Miscellaneous Report No. 237. They show that dosages picked up by locusts resting on trees and on the ground can be considerably greater than would be suggested by deposits on the ground, particularly when there is a strong wind and the droplets are small.

4. Rotary Atomisers fitted to aircraft

The present Britten-Norman rotary atomiser, fitted to the Auster aircraft, produces droplets somewhat larger than those believed to be ideal for tsetse eradication in savannah woodland. Attempts have been made to reduce droplet sizes, both by increasing the diameter of the rotating cages, and by reducing the mesh size of the gauze itself, but so far no appreciable improvement has been obtained. Further experiments are being planned.

5. Analysis of sample papers from Taveta-Pare house spraying

Sample papers from one hundred and sixty-nine houses were analysed during the sixth and final spraying cycle. Roof, wall and "expected" deposits were determined (an explanation of these terms is given in C.P.R.U. Annual Report, 1950, 22, 9). The distributions of the roof, mean wall, and expected deposits were negatively skewed and could be normalised by logarithmic transformation. The geometric means of the deposit were:-

Roof:	0.48 gm/sq. m
Mean wall:	0.54 gm/sq. m
Expected:	0.50 gm/sq. m

The 95 per cent fiducial limits were:

Roof:	0.16-1.13 per sq. m
Mean wall:	0.20-1.21 per sq. m

The roof deposits were significantly correlated with the mean wall deposits, and the correlation of mean wall deposits with "expected" deposits was also significant. A Barlett test revealed no significant difference between the dosages applied by the individual teams.

IMPERIAL COLLEGE, INTERIM REPORT, OCTOBER 1959

Mode of action of Insecticides

Work on the effect of chlorinated hydrocarbon insecticides on the cholinesterases of extracts of the heads of various species of insects has been continued. An attempt was made, by the use of high speed centrifugation, to determine whether the cholinesterase activity of head extracts resided in the mitochondria. Several fractions were obtained and their activity measured. The effects of dieldrin and chlordane at final concentrations of about 10-3M on these fractions were also measured.

The results have not yet been fully analysed, but they do show that cholinesterase activity could be concentrated in one fraction (the mitochondria) but that the other fractions still retained some activity. The effects of dieldrin and chlordane on the activity of the "mitochondrial" fraction were opposite to their effects on the activity of the supernatant, a discovery which suggested that total cholinesterase activity was due to at least two enzymes which had been separated by centrifugation.

Experiments are now in progress using three cholinesterase inhibitors: (1) eserine sulphate (a general cholinesterase inhibitor) which was found completely to inhibit the acetylcholinesterase activity of both a susceptible strain of Musca domestica and a dieldrin-resistant strain of Musca vicina: (2) iso-OMPA specific for pseudocholinesterase: (3) "62-C-47" which specifically inhibits true acetylcholinesterase. The results show that both pseudocholinesterase and true acetylcholinesterase are present in the head extracts of both species of houseflies together with one or more other cholinesterases which account for about 10-20% of the total activity.

Quantitative analysis of these and previous results has been rendered more difficult by the discovery that the pseudocholinesterase is very much more labile than the true acetylcholinesterase. To complete the present series of experiments the rates of loss of activity of the labile pseudocholinesterase are being determined for head extracts of different species.

The work on the diffusion of oil films on flies has been temporarily suspended while an extension is being added to the radioactive tracer laboratory.

Olfactory Responses of Stomoxys calcitrans

Work on the olfactory behaviour of hungry 1-2 day old adult Stomoxys calcitrans has been continued.

It has been found possible to feed the adult flies on blood containing IHT (sodium chloride, 7 g: sodium citrate 5 g: potassium chloride 0.2 g: magnesium sulphate 0.04 g: distilled water to 1 litre. Mix with equal volume of blood) Bagdassarov, L., 1937. Sang, 11, 466) which had been stored at room temperature for three weeks. Blood containing 3% sodium citrate must be stored at 4°C.

The small choice chamber (see report of April, 1959) has been used to observe the responses of flies exposed to the saturated vapours of certain ethyl and ammonium derivatives of straight chain fatty acids. Some results are given in the attached table. It will be seen that none of the esters were attractive and that the series showed a minimum effect on the flies at C_5 and C_6, after which repellency tended to increase with molecular weight. These results contrast with those given for normal fatty acids in the last report, the saturated vapours of acids being attractive over the range C_{12} to C_{18}.

A mixture of fatty acids in the same proportions as they are found in human sebum (C_{12}, 4 parts: C_{14}, 6 parts, C_{16}, 24 parts: C_{17}, 1 part: C_{18}, 8 parts. - James & Wheatley, 1956) has also been tested. The saturated vapour of the mixture was less attractive than palmitic acid, which is one of the most attractive members of the series and is also present in the greatest concentration in human sebum.

The olfactometer, described in a previous report (April, 1957) is being used to study the behaviour of single flies when stimulated by different concentrations of the lower fatty acids. Preliminary experiments showed that concentrations of approx. 3×10^{-4} g/l of valeric acid were attractive, whilst concentrations of approx. 6×10^{-4} g/l were repellent. It is hoped to study the behaviour of single flies within this range of concentrations and to relate any change in behaviour to the concentrations of the stimulus. In addition, thresholds of response obtained by these means will be compared with those obtained by an electrophysiological technique which is being developed.

	Molecular weight	% time spent over stimulus	Frequency of stopping (Stops/sec x 10^3)	Length of pause (in sec)	Frequency of turning (turns/cm)
Ammonium butyrate	104	38	2.7	18	0.21
valerate	118	47	2.5	21	0.15
caproate	132	40	2.5	19	0.16
caprylate	160	28	2.5	37	0.16
Ethyl butyrate	125	42	1.7	70	0.45
caproate	152	50	1.4	36	0.17
caprylate	180	38	1.5	16	0.19
laurate	236	46	2.6	15	0.22
myristate	264	40	1.5	47	0.15
Sebum mixture	-	56	2.3	43	0.24

ROTHAMSTED EXPERIMENTAL STATION. HALF YEARLY PROGRESS REPORT 1st APRIL-30th SEPTEMBER, 1959 TO THE COLONIAL PESTICIDES RESEARCH COMMITTEE.

The effect of formulation on the toxicity of DDT deposits on plates and leaves

The relationship between the nature of insecticidal deposits and their contact toxicity has been studied, using the bioassay procedure in which houseflies are constrained to remain on the test surface by means of a temperature gradient. The nature of the deposit is determined by the constitution of the spray solution and also the type of surface upon which it is sprayed. The toxicity of a deposit is liable to alter during storage, partly as a result of growth of crystals.

Types of Deposit

(a) Liquid Paraffin. The spray solvent consists of 78 parts xylene, 20 parts ethylene glycol monoethyl ether and two parts of liquid paraffin. DDT is dissolved in this mixture, to give the range of concentrations required by the experiment. When sprayed in the Potter Tower, the formulation gives deposits which will not crystallize even when the original solution contains 0.15% DDT.

(b) DDT emulsions were made by mixing 25% w/v DDT in xylene with a non-ionic wetting agent (Agral LN; Plant Protection Ltd.). Additives such as coumarone resin or aluminium stearate were dissolved in xylene and added at this stage. The mixture was mechanically stirred while the water was added, slowly at first. All the emulsions sprayed in the tower contained 0.1% wetting agent.

(c) Crystalline suspensions were made by the method of McIntosh and consisted of DDT needles 60μ long. Some of these are broken in the process of spraying, so that the mean size of the crystals in the deposit is somewhat smaller.

Types of surface upon which deposits were tested were: plain glass plates; glass plates coated with a thin uniform layer of paraffin wax; cabbage leaves. Selected flat portions of the leaves were attached to glass plates by adhesive tape in such a way that the test area was entirely covered with leaf. The leaves survived in the constant temperature room for 24 hours without shrivelling.

Effect of ageing of deposits

Emulsion deposits on wax-coated plates were found to increase in toxicity when stored in the constant temperature room. Microscopical examination showed that the degree of crystallization of the deposit increased during storage. Table I shows the kill obtained when wax-coated plates sprayed on three successive days were tested simultaneously (5-min exposures).

Table I

Effect of age on the toxicity to houseflies of residual films on wax-coated plates from DDT-xylene emulsion and DDT-xylene-liquid paraffin solution.

Solution sprayed	Age of deposit, days	No of houseflies	Mortality, per cent.	Deposit density $\mu g/cm^2$ (Chemically determined on replicate plates)
DDT emulsion	0	47	19	4.1
	1	57	25	4.8
	2	54	48	4.5
DDT/Liquid paraffin	0	34	73	0.9
	1	36	69	1.3
	2	36	72	1.3
Unsprayed control	-	20	0	0

There is no significant change in the toxicity of the DDT/liquid paraffin films.

The increase in toxicity of deposits from DDT suspensions on glass, which was observed when *Tribolium castaneum* was test-organism, was also evident when houseflies were used. Table II shows the kills obtained when three batches of plates of differing ages were tested.

Table II

Effect of age on the toxicity to houseflies of residual films on glass plates from a DDT suspension of 60µ needles. Exposure time five minutes.

Age of deposit, days	No. of houseflies	Mortality, per cent	Deposit density µg/cm^2	(Chemically determined on replicate plates)
0	96	43	3.3	
9	96	63	3.8	
16	91	87	3.9	
Untreated Control	40	0	0	

The increase in mortality given by the nine-day old deposit may have been caused by the slightly greater deposit density, but that of the 16-day old is too great to be accounted for in this way, and must be due to a physical change.

Emulsion deposits on leaves also increase in toxicity during the first 24 hours; they cannot be kept for longer periods because of the wilting of the leaves. Table III shows the effect.

Table III

Effect of age of deposit on the toxicity to houseflies of residual films on cabbage leaves from DDT-xylene emulsions.

Age of deposit days	No. of houseflies	Exposure min	Mortality %	Deposit density µg/cm^2	(Chemically determined on replicate plates)
0	45	2	56	10.5	
1	52	2	100	10.2	
0	55	3	96	10.5	
1	55	3	100	10.2	
Untreated Control	40	2	3	0	

Deposits on glass plates

Table IV shows that, on unwaxed plates, the suspension and liquid paraffin type formulations give deposits of similar toxicity in a series of four separate determinations.

Table IV

Comparison of the toxicity of deposits on unwaxed glass plates from suspensions of 60µ needles of DDT and DDT-xylene-liquid paraffin solutions

LD50, in µg of DDT per sq. cm (Exposure time 3 minutes)

Liquid paraffin formulation	1.30, 1.75
Suspension	1.05, 1.30

An early experiment showed that DDT suspension was markedly more toxic on plain than on wax-coated glass, perhaps because the crystals adhere to the wax. (This is shown by washing suspension-sprayed plates with water; the DDT is all removed from plain glass plates, but not from wax-coated ones). Results of the comparison are given in Table V.

Table V

Comparison of the effect on the toxicity to houseflies of suspensions of 60µ needles of DDT on a plain glass substrate and a waxed glass substrate

Exposure time, min	Plain Glass	Wax-coated glass	Deposit density, µg/cm^2
3	96	-	11.8
4	96	33	11.8
5	92	91	11.8

The results given in Table I above show that the liquid paraffin type deposit is at least four times as toxic as the emulsion type, when sprayed on plates coated with paraffin wax, the comparison being made using deposits 24 hours old.

The toxicity of liquid paraffin-DDT deposits is not much affected by the wax coating, as may be seen by comparing the results for this formulation in Tables I and IV. The emulsion formulation gave very variable results on plain glass, and consequently was little used. In one experiment, reported in detail below (Table VII), a deposit of 7.6 µg/cm^2 gave a corrected kill of 11% when tested 24 hours after spraying. Table I shows that the LD-50 of emulsion on wax-coated plates tested 24 hours after spraying was greater than 4.8 µg/cm^2. It is probable, therefore, that the toxicity of emulsion deposits also is little affected by the presence of a wax coating on the plates.

Deposits on cabbage leaf

The DDT-liquid paraffin type of deposit was less toxic on leaves than on wax-coated glass plates. Table VI shows the result of a direct comparison.

Table VI

Comparison of the effect on the toxicity to houseflies of DDT-xylene-liquid paraffin deposits on leaves and on wax-coated glass plates.

Type of support	Exposure time, min	No. of houseflies	Mortality, per cent	Deposit density µg/cm^2 (Chemically determined on replicate plates)
Cabbage leaf	3	114	29	3.3
Cabbage leaf	4	46	65	3.3
Waxed plate	3	56	100	3.3
Control	3	40	10	0

The variations in kill between replicates were rather high, perhaps because of variations in texture between different leaves.

Xylene-emulsion, on the other hand, gave deposits on leaves which were much more toxic than those on glass plates whether wax-coated or not. In a series of seven separate experiments, the LD50 of emulsion on leaves, using a 5-min exposure, varied between 1.4 and 2.6 µg/cm^2, a toxicity almost as great as that of liquid paraffin/DDT on plates as shown in Table IV. In the tests of emulsions containing additives sprayed on leaves, therefore, plain DDT-xylene emulsion was used as a standard of reference.

Effect of additives in emulsions

It has been reported (van Tiel, Bull. ent. Res. 43, p.413, 1952) that DDT-kerosene emulsions give deposits of increased toxicity if they contain coumarone resin (10% of the weight of DDT). An investigation was made of the effect of addition of coumarone resin on the immediate toxicity of DDT-xylene emulsions on glass plates to houseflies. The effect on persistence was not studied. Table VII gives the results.

Table VII

Toxicity to houseflies of residual films on glass plates of DDT-xylene emulsions with and without coumerone resin. Exposure time 5 minutes; films kept for 24 hours before test.

	Plain DDT-xylene emulsion		Coumarone-DDT-xylene emulsion	
conc. sprayed % DDT	Mortality per cent	Deposit density µg/cm² (Chemically determined on replicate plates)	Mortality per cent	Deposit density µg/cm² (Chemically determined on replicate plates)
0.2	11	7.6	-	-
0.15	16	7.0	80	7.4
0.10	5	4.4	65	4.1
0.075	0	3.4	60	3.2
0.05	-	-	40	1.9

(Mortalities corrected for 3% control deaths).

When sprayed on to cabbage leaves, emulsions containing coumarone resin give deposits which are no more toxic than those from plain emulsion, as shown in Table VIII.

Table VIII

Comparison of the toxicity to houseflies of films from DDT-xylene emulsions and coumarone-DDT-xylene emulsion on a leaf surface. Exposure time 5 minutes, films kept for 24 hours before test.

	Plain DDT-xylene emulsion		Coumarone-DDT-xylene emulsion	
conc. sprayed % DDT	Mortality per cent	Deposit density µg/cm²	Mortality per cent	Deposit density µg/cm²
0.05	77	1.9	97	2.1
0.025	39	1.1	11	1.1
0.013	3	0.6	0	0.5

(Mortalities corrected for 3% control deaths).

Some other experiments were carried out on the effect on toxicity to houseflies of additives to DDT-xylene emulsions on leaves and unwaxed and waxed glass plates.

An emulsion containing two parts by weight of the resin Arochlor 5460 to one of DDT gave a deposit of very low toxicity on leaves, no kill being obtained with the heaviest deposit tested (7.2 μg/cm^2 of DDT). The addition of one part of olive oil to ten of DDT gave an emulsion which, tested on wax-coated plates, was about as toxic as that from plain DDT-xylene emulsion. In both instances the films were kept for 24 hours before test and the insects given a 5 minutes exposure.

The addition of aluminium monostearate to DDT-xylene emulsions has an effect on the form of the crystals produced when sprayed on to glass plates. A comparison was therefore made between the toxicity of deposits made by spraying glass plates with plain DDT-xylene emulsion containing one part of aluminium monostearate to ten of DDT by weight with 24 hours old films and a 5 minutes exposure. The LD-50 for plain emulsion was about 10 μg/cm^2 and that of the modified emulsion 2.5 μg/cm.^{2}. When the comparison was repeated, using cabbage leaves, the respective LD-50's were 2.1 and 1.8, i.e. not significantly different.

Toxicity of suspension deposits on leaves

A direct comparison was made between the toxicity to houseflies of DDT 60μ needle suspension and DDT-xylene emulsion deposits on leaves. Emulsion gave an LD-50 of 1.9 μg/cm^2; suspension gave 100% mortality at all deposit levels, the lowest tested having been 2.1 μg/cm^2. As before, the films were kept for 24 hours before test and an exposure time of 5 minutes was used. This indicates that on leaves, when tested for initial toxicity, suspensions give a more toxic deposit than emulsions. No information was obtained on persistence.

Physical appearance of deposits

It is very difficult to see crystals of DDT on most leaves by direct microscopic examination. The nature of the deposits was therefore investigated by making casts of the leaves in strong gelatine solution, using the method of Martin and Batt. The various additives to the DDT-xylene emulsion did not appear to produce any striking differences to the deposits when sprayed on leaves. Crystallization was not extensive, being confined to a few small centres at the time of the examination, i.e. 24 hours after spraying. Comparison with the much more extensive crystallization on glass showed that the crystalline material seen on leaf impressions was only a small proportion of the DDT on the leaf.

Summary

The method of test of insecticidal deposits in which houseflies are constrained to walk on and remain on the deposit by means of a thermal barrier, was used to study the initial toxicity of deposits on glass plates and leaves formed by spraying various formulations of DDT.

On glass plates, DDT-xylene emulsions gave deposits which were less toxic than those from either a suspension of 60 µ long needle crystals or a solution of DDT in xylene and ethylene glycol monoethyl ether that contained enough liquid paraffin to prevent crystallization. Coating the glass plates with a thin layer of paraffin wax reduced the toxicity of the suspension deposits but did not materially affect the others. Addition of either coumarone resin or aluminium monostearate in an amount equal to one tenth of the DDT, resulted in deposits on glass which were two to four times as toxic as those from plain emulsion.

When cabbage leaves were used instead of glass plates, plain DDT-xylene emulsion gave more toxic deposits and liquid paraffin/DDT gave less toxic ones. The addition of coumarone resin, or aluminium monostearate at the same rate to the emulsion did not affect the toxicity on leaves as it had on glass plates, the deposits being no more effective than those from plain emulsion. The addition of large amounts of Arochlor resin reduced the toxicity on leaves.

DDT-xylene emulsion deposits on leaves and on wax-coated glass plates increase in toxicity as crystallization proceeds. Suspension deposits on glass also increase in toxicity with age, but to a much lesser extent. Liquid paraffin deposits do not alter in toxicity with age, at least during the first two days.

GLASSHOUSE CROPS RESEARCH INSTITUTE. Annual Report, 1958.

Red Spider Mite Control (W. H. Read)

"Investigations on the control of Glasshouse Red Spider Mite have been continued.

Almost complete eradication of red spider throughout the block of cucumber houses at the Institute was obtained by one application of a diazinon aerosol applied at 1.5 grammes per 1,000 cu.ft., but laboratory investigations confirmed that this could not be accounted for by the persistence of diazinon or pronounced ovicidal action. The mortality of adult female mites (red strain) sprayed with diazinon at 125 p.p.m. was 99%, but at 500 p.p.m. there was no significant effect on eggs. Larvae emerging from eggs four days after treatment were unaffected by residual deposits on sprayed leaves.

"Tedion" (2:4:5:4'tetrachlorodiphenyl sulphone) had pronounced ovicidal action. Spraying with this chemical at 500 p.p.m. killed 97.8% of the eggs, but at 125 p.p.m. only 66.9%. Against adult mites it was less effective; the percentage mortalities after ten days were 49.8 at 500 p.p.m. and 31.6 at 125 p.p.m.

Although some female mites sprayed with the tetrachlorodiphenyl sulphone laid infertile eggs, those from other females developed normally to mature, fertile females".

Systemic insecticides (V. A. Gentle)

"An examination of the relative values of certain systemic compounds for the control of pests of glasshouse crops has been commenced. Preliminary results have shown that 0.0-diethyl-S-(ethylthiomethyl) phosphorodithioate ("Thimet") is readily absorbed from soil by cucumbers in acaricidal amounts, whereas 0.0-dimethyl-s-(N-methylcarbamoylmethyl) phosphorothiolothionate ("Rogor") is either less readily absorbed, more rapidly converted to non-acaricidal compounds within the plant, or is less toxic to red spider. "Phosdrin" (2-methoxy-carbonyl-1-methylvinyl dimethyl phosphate) was not absorbed from the soil and translocated sufficiently rapidly by young cucumber plants to effectively control active stages of red spider".

THE CONTACT TOXICITY OF TRITHION AND METHYL TRITHION TO ANOPHELES STEPHENSI

A. B. HADAWAY and F. BARLOW, Colonial Pesticides Research Unit, Porton. Report No.166. October, 1959.

Materials and Methods

The insecticides tested were manufactured by the Stauffer Chemical Company, and consisted of

(a) 50% Trithion wettable powder, (ref. W.H.O./708).

(b) 50% Methyl Trithion wettable powder (ref. W.H.O./744).

Four plywood panels were sprayed with an aqueous suspension of each formulation at a dosage of 100 mg active ingredient per sq. ft (= 1g/m^2).

Test insects were blood-fed, 2-3 day old female mosquitos (*Anopheles stephensi*). Batches of ten mosquitos were introduced into perspex chambers $2\frac{1}{2}$ in. in diameter and 1 in. deep and were allowed to alight and rest on the plywood panels approximately one hour after treatment. After the required contact times the mosquitos were "knocked down" with carbon-dioxide and transferred to holding cages which were stored at 25°C and 60-70% relative humidity for 24 hours before mortality counts were made.

Results

Percentage mortalities after various contact times were as follows:-

	15 min	30 min	60 min	120 min
Trithion	0	0	13	90
Methyl Trithion	0	5	38	98
Malathion	100			

Although Methyl Trithion was slightly more effective than Trithion, neither compound showed a high enough level of toxicity to Anopheles stephensi to warrant extensive tests on residual properties on a variety of building materials.

THE CONTACT TOXICITY OF SOME ORGANO-PHOSPHORUS INSECTICIDES TO ANOPHELES STEPHENSI.

A. B. HADAWAY and F. BARLOW, Colonial Pesticides
Research Unit, Porton. Report No.167. October, 1959.

Earlier, the toxicities of twelve organo-phosphorus compounds to mosquitos and houseflies were determined by topical application of solutions to individual insects. The results were given in CPRU/Porton/ Report No.164. See PANS (A) 1959 5, (4), 515. The initial and residual contact toxicities of deposits of some of these compounds have now been investigated.

Materials and methods

Blood-fed female mosquitos (Anopheles stephensi), 2-3 days old, were used in all tests. Batches of ten mosquitos were introduced into perspex chambers $2\frac{1}{2}$ ins. in diameter and 1 in. deep, and were allowed to alight and rest on the treated surfaces. After the required contact times the mosquitos were "knocked-down" with carbon-dioxide and transferred to holding cages which were stored at 25°C and 60-70% relative humidity for 24 hours before mortality counts were made.

Test surfaces consisted of plywood panels, dried mud bricks and glass plates. A number of each were sprayed at the required dosage and stored vertically in racks in a room measuring 14 x 12 x 7 ft and maintained at 25°C and 60 ± 10% relative humidity. Exposures of mosquitos were made at different times after treatment on two previously unused surfaces.

Results

"Rogor" is a liquid with a solubility of about 3% in water, and no wettable powder is available, but because of the high level of toxicity shown by a solution applied topically it was considered worthwhile investigating the contact toxicity of deposits from an emulsion. A 40% emulsion concentrate, supplied by Fisons Pest Control Ltd., was diluted with water to give a 3.2% emulsion which was sprayed on to test surfaces at a dosage of 100 mg "Rogor" per sq. ft. A few hours later the deposits on glass plates were highly toxic to mosquitos, but those on plywood panels and mud bricks were ineffective after a contact time of one hour. The results are shown in Table 1.

Table 1

	Percentage kill after contact time of		
	2 min	15 min	60 min
Glass	100		
Plywood		0	9
Mud		0	0

Aqueous suspensions of the following wettable powders were sprayed on to plywood panels at a dosage of 100 mg active ingredient per sq. ft.

40% Diazinon wettable powder, supplied by the Geigy Co. Ltd.

30% Malathion wettable powder, supplied by Ratsouris Ltd.

25% Trolene (Dow ET-57) wettable powder, supplied by Dow Agrochemicals Ltd.

20% Chlorthion wettable powder)
30% Resitox wettable powder) supplied by Farbenfabriken Bayer.
25% Gusathion wettable powder)

Additional panels were sprayed with the diazinon wettable powder at dosages of 50 and 25 mg diazinon per sq. ft.

The initial and residual contact toxicities to A. stephensi are given in Table 2.

Table 2

Insecticide	Dosage mg/sq. ft	Age of deposit	Percentage kill after contact time					
			2	5	15	30	60	120 min
Diazinon	100	Few hours	100					
		1 week	100					
		2 weeks	25	100				
		4 weeks			0	30	98	
		7 weeks				0	0	13
Diazinon	50	Few hours	100					
		1 week	35	80				
		2 weeks		15	95			
Diazinon	25	Few hours	100					
		1 week	0	0	65			
		2 weeks				45		
Malathion	100	Few hours	20	71	100			
		1 week		36	100			
		2 weeks		21	100			
		4 weeks		15	98			
		7 weeks		5	80	100		
		10 weeks		0	77	100		
Trolene (Dow ET-57)	100	Few hours	0	50	100			
		1 week		28	100			
		2 weeks		16	100			
		4 weeks		18	90			
		7 weeks			5	3	10	
Chlorthion	100	Few hours		5	58	85		
		1 week			60	90		
		4 weeks		0	45	75		
		7 weeks		5	49	76		
Resitox	100	Few hours			0	0	0	
Gusathion	100	" "			0	0	0	

It can be seen that, on plywood panels,

1. deposits of diazinon at a dosage of 100 mg per sq. ft were highly toxic initially, but their effectiveness decreased rapidly after 2 weeks.

2. deposits of malathion were less toxic than those of diazinon initially, but there was little change in toxicity for 10 weeks (tests are continuing).

3. deposits of Trolene were as toxic as those of malathion for 4 weeks, but became relatively ineffective after 7 weeks.

4. deposits of chlorthion were less toxic than those of malathion, but there was little change in effectiveness after 7 weeks (tests are continuing).

5. deposits of both "Resitox" and "Gusathion" were ineffective initially despite the high level of toxicity of both compounds by topical application of solutions

Aqueous suspensions of the wettable powders were also sprayed on to dried Uganda mud bricks at a dosage of 100 mg active ingredient per sq. ft. The toxicities of the deposits to A. stephensi are given in Table 3.

Table 3

Insecticide	Age of deposit	Percentage kill after contact time of					
		5	15	30	60	120	240 min
Diazinon	Few hours				0	16	
Malathion	Few hours		18	70	100		
	4 days				0	15	
	13 days					5	75
Trolene	Few hours	14	40		100		
	1 day		0		35		
	4 days		0		0		
Chlorthion	Few hours				0	0	
Resitox	Few hours				0	0	

It can be seen that only malathion and "Trolene" wettable powders gave toxic deposits on the surface of the dried mud bricks and these rapidly lost their effectiveness.

Investigations on the evaporation, decomposition, absorption and adsorption of organo-phosphorus compounds will be described in a separate report. It is hoped that they will provide information which will lead to improved and effective formulations. At present, however, it may be concluded that, of the compounds tested, only malathion has any promise as a residual insecticide against mosquitos and even this probably has a limited use because of its short residual life on some dried mud surfaces.

THE TOXICITY OF SEVIN TO MOSQUITOS

A. B. HADAWAY and F. BARLOW. Colonial Pesticides Research Unit, Porton. Report No.168. November, 1959.

In these tests with "Sevin", 1-naphthyl N-methylcarbamate, the pure recrystallised compound was used in topical applications, and a 50% wettable powder was used in contact toxicity tests.

Test insects were 2-3 days old, blood-fed, female *Anopheles stephensi* and *Aedes aegypti* reared by standard methods at 25°C.

Toxicity by topical application

Topical applications of "Sevin" solutions in di-isobutyl ketone were made to the dorsal surface of the thorax of mosquitos from a microburette. Small measured volumes of a 0.02% solution were applied to *A. stephensi*, and of a 0.1 per cent. solution to *A. aegypti*. After treatment, mosquitos were stored in holding cages at 25°C. and 60-70% relative humidity for 24 hours before mortality counts were made. It was noted that specimens of both species appeared to be affected and "knocked-down" but recovered subsequently. The following results show that "Sevin" is highly toxic to *A. stephensi*, but less toxic to *A. aegypti*.

Species	Dosage µg. "Sevin"/ mosquito	No. of mosquitos	% age kill	Regression line	LD.50. µg. per mosquito
A. stephensi	0.0045	60	72	y = 7.75x +0.59	0.0037
	0.0036	60	48		
	0.0029	60	22		
	0.0022	60	2		
A. aegypti	0.0225	60	92	y = 7.12x +3.85	0.0145
	0.0180	60	73		
	0.0144	60	52		
	0.0108	60	17		

Contact Toxicity

Plywood panels and dried mud bricks made from Babati (Tanganyika) soil were sprayed with "Sevin" wettable powder at a dosage of 100 mg active ingredient per sq. ft. (= 1 g per m^2). Female A. stephensi were exposed to the treated surfaces a few hours later. Batches of ten mosquitos were introduced into perspex chambers $2\frac{1}{2}$ in. in diameter and 1 in. deep, and were allowed to alight and rest on the treated surfaces. Contact with the deposits did not activate the mosquitos which remained at rest on the treated surfaces for the entire exposure periods. After the required contact times the mosquitos were "knocked-down" with carbon-dioxide and transferred to holding cages which were stored at 25°C and 60-70% relative humidity for 24 hours before mortality counts were made. The following results were obtained:-

Material sprayed	Percentage kill after contact of .... minutes		
	15	60	120
Plywood	0	0	0
Dried mud	0	0	0

It can be seen that the wettable powder deposits were non-toxic to A. stephensi after a contact period of 2 hours, although "Sevin" was highly toxic when applied topically in solution. Deposits of malathion wettable powder at the same dosage on plywood panels gave 100% kills after 15 minutes contact.

THE SUSCEPTIBILITY TO INSECTICIDES OF ANOPHELES GAMBIAE FROM KAMPALA DISTRICT

J. A. ARMSTRONG. Colonial Pesticides Research Unit, Arusha.
Tanganyika Misc. Report No.242. 1959.

Measurements were made of the susceptibility levels of wild caught adult female Anopheles gambiae exposed to DDT and dieldrin, and of females, bred from larvae and eggs, exposed to DDT, dieldrin and gamma BHC. Figures for colony A. gambiae females are also given.

THE DISTRIBUTION OF SPRAY ON MAIZE PLANTS.

P. T. WALKER. Colonial Pesticides Research Unit, Porton.
Report No.169. December, 1959.

Insecticide sprays are used for the control of cereal stalk borers and other insect pests of maize, sorghum and rice, and have been shown to be highly effective against the African maize stalk borer, Busseola fusca Fuller in East Africa (Walker, in the press).

The behaviour of the different species varies to an extent which should influence the choice of spray pattern adopted for their control. The American Pyrausta nubilalis lays batches of eggs on the underside of the maize leaves as do the pyralid borers on maize and sorghum in East Africa. Busseola fusca and probably Sesamia spp. lay their eggs under the leaf sheaths round the stem. It is thus more important to have a toxic deposit of insecticide on the stem for the maximum control of Busseola than for Chilo, Pyrausta and similar Pyralidae. This has been demonstrated in a field trial with endrin emulsion on maize, (Walker, op.cit.), when spraying the stems was found to contribute half the control effect of spraying the whole plant.

A chemical estimate from the same trials of the amount of endrin retained on a small maize plant is also available.

A preliminary investigation of the distribution of spray on small maize plants has therefore been carried out in order to find how much spray is deposited on the main parts of the plant, and what loss of spray occurs.

Method

Small maize plants of two heights, one foot and one and a half feet, placed one yard apart, were sprayed with a known concentration of croceine scarlet in water, vertically downwards, from a height of one foot above the top of the plants.

One flat-fan Bray-type size 00 ceramic-jet nozzle was used, which was calibrated and found to deliver 8 ml of water per second (28.8 litres per hour) at a constant pressure of 25 lb/sq. in.

The width of swathe was determined at different distances from the nozzle, and found to be about one foot nine inches to two feet at a distance of one foot. This distance was taken as the working height above the plants.

The nozzle was carried over the plants at the speeds given, the usual speed being a slow walking pace of 2.14 seconds per yard, or just under 1 m.p.h. The plants were sprayed during calm conditions in the early morning.

The sprayed plants were then cut into three arbitrary divisions; the stem, from ground level to where the leaves bend outwards; the whorl, including about an inch of the visible base of the leaf blades; and the leaves. Each division was washed with water in a closed "kilner" bottling jar, and the amount of croceine scarlet in the washings estimated by means of a "Unicam" absorption colorimeter at the wavelength for maximum absorption.

Results are expressed as the amount of dye found on each division of the plant, and hence the total amount of the plant. These amounts are also given as percentages of this total. The total is then calculated as a percentage of the amount of dye delivered over an arbitrary area of 4 sq. ft (2 ft swathe by 2 ft run). Tests were made with plants of the following heights, 1 ft 6 in, 1 ft and 9 in - 12 in.

Results

The results are recorded in detail in four tables. A general picture of the total amount of spray retained by plants of different sizes is shown in the table below

Height of plant	Speed of travel	% of spray retained
1' 6"	about 1 m.p.h.	22% (13-30%)
"	about 0.7 m.p.h.	33%
"	stationary burst of 1 second	32%
1'	about 1 m.p.h.	7%
9"-12"	about 2 m.p.h.	1-2% ø

ø Based on chemical estimation (Walker, op.cit.)

These figures are all calculated as a percentage of the amount of spray by volume delivered over an area of 4 sq. ft (2' x 2'). The smaller plants naturally receive less. The amount retained is obviously related to area and there will therefore be a geometric relation to plant height. On examination of the proportion of spray retained on different parts of the plant, relatively more spray is found to reach the stem and whorl than the leaves at a slower rate of travel over the plants. When the nozzle is stationary over the plant, the whorl retains relatively 2-3 times more, and the leaves still receive less than before. There are, however, insufficient replicates to prove this.

The chemical estimate of insecticide retention by small plants, 9" to 12" high, in a previous field trial is shown to be in the same order as the present results.

Some of the differences between replicates can be explained, firstly by the difficulty in defining the exact divisions of each plant, and secondly by the differences in leaf shape and arrangement, causing considerable chance variation in the amounts of spray hitting the different parts.

It is intended to investigate the effect of changing the size of the nozzle aperture and hence the spray characteristics, and also the angle and position of the nozzle, all factors likely to influence the rate of deposit of insecticide and hence the degree of insect control.

Area of Plant

In the last trial, an attempt was made to relate the spray retention to the area of the plant when seen vertically from above. By means of photographs and a planimeter, the areas of the plant, leaves and whorl, visible from above, were measured.

It was found that about 1½-3% more spray is retained by this size of plant than can be accounted for by plant area. The difference is doubtless due to retention on the stem and underside of the whorl and leaves.

Drop Spectrum

As the drop size can influence the amount of spray reaching and being retained by various parts of the plant, the characteristics of the spray were determined by the physics section.

Drop sizes were determined by measurement of stain size as sampled on Whatman filter paper, after ageing for 24 hours, stain size being converted to drop size by means of a pre-determined calibration. The cumulative percentage by volume of drops finer than the stated size are given in the following table:-

Volume diameter (μ)	Cumulative % (volume)
100	10
155	50
250	90

Percentage of drops (number)

between	70-100 μ	29%
"	100-130 μ	27%
"	130-160 μ	25%
"	160-240 μ	13%

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REVIEW ARTICLE

REPORT ON A VISIT TO THE SOUTHERN CAMEROONS

BY P. O. PARK* and E. C. HISLOP/ Colonial Pesticides Research Unit, Arusha.

The two members of the West African Fungicides Research Unit visited the Southern Cameroons during July 1958 in connection with their work on black pod disease of cacao and studied the incidence of the disease and control measures in use. It was expected that they would also examine other disease problems of cacao in this area. At the request of the Principal Agricultural Officer, Southern Cameroons, the visit was extended to include a study of Sigatoka disease of bananas and of various conditions of coffee in the Bamenda area. P. O. Park also had discussions with the Helminthiasis Research Unit, Kumba on the mud samples being submitted to the C.P.R.U., Arusha for insecticide determination and visited one of the sites of this experiment.

CACAO

Black Pod (Phytophthora palmivora Butl.)

The incidence of black pod at the time of the visit was not high because of unusually dry climatic conditions. Various routine control measures were being applied, and the general impression was that, if control measures were performed diligently, losses caused by black pod were reasonably low. For use on peasant farms, approximately 8000 sprayers have been sold and of these, knapsack and syringe types are about equally popular. However, it is suspected that, owing to the growing popularity of banana cultivation, the cacao spraying programmes are not being fully carried out.

One progressive farmer in the Kumba area is spraying some of his cacao with a motorised knapsack sprayer and has recently put into operation a tractor-drawn mist-blower. This method of spraying was also in use at Colonial Development Corporation's Tombel estate with Kiekens Dekker mist-blowers drawn by Ransome MG. crawler-tractors, travelling along every second row of trees and applying 2 lb per acre of fungicide (50% copper as cuprous oxide in 15 gal. During the period of heavy rainfall a 2-weekly cycle is in use; at other times 3-weekly. This system of spraying is cheaper than the relatively high volume spraying using pressure-retaining knapsack sprayers which is in use on uneven and inaccessible parts of the estate. It is of interest to note that the estate at Tombel, which is now yielding well, was abandoned until 10 years ago. Good cultural practices and routine spraying for insect and disease control have brought the estate back into production.

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* At present on secondment for fungicide work in West Africa.

/ Now at West African Cocoa Research Institute, Tafo, Ghana.

The fungicide trials at Kumba sponsored by Plant Protection Ltd. were visited. It is fortunate that much cacao in S. Cameroons, even old-established, is in straight lines which makes both the mechanical disease control measures and experimental work simpler.

A culture of the Cameroons isolate of P. palmivora was obtained from Mr. West.

Leafless Twig

This was observed on a number of peasant holdings, at the Department of Agriculture farm, Barombi Kang and at the Cadbury and Fry estate, Ikiliwindi. Both mature and young cacao were affected. Martini (1958) has reported on the various symptoms of this condition and on the factors with which it seems to be associated. The observations made during this visit confirm his conclusions and the leaf tip necrosis reported by Donald and Wharton (1957) was also noted.

"Paint brush top" to the leading shoot of young cacao was seen at Ikiliwindi and Tombel. Many of the affected shoots were suffering caterpillar attack, but it is doubtful if the condition and the infestation are related, (Martini 1958).

A regular regime of 4 weekly spraying against psyllid attack has been recommended (Dept. of Agric. 1956), but it is probable that this is not always justified. A cold frame of polythene sheet has apparently proved effective in curing leafless twig on cacao in the nursery at Tombel.

It is possible that the difficulties reported in the establishment of Amazon cacao seedlings are due to bad cultural methods. A seedling should not be uprooted from the Whale-hide pot for transport, as the root system will be damaged or distorted. Similarly before planting, the Whale-hide pot should be substantially removed, as quick disintegration of these pots in the soil does not always occur. It may be significant that at Ikiliwindi, where Whale-hide pots were found unrotted after two years, the soil pH is low (4.5).

Conclusions

As the routine methods of black pod control were adequate and since the programme of West African Fungicides Research Unit for the first year is to be on a laboratory scale, there is no work than can usefully be done on this disease in the S. Cameroons at present. While a number of advantages for carrying out future field experiments in the Cameroons can be listed (regularly-planted high-yielding cacao in an area of high black pod incidence) there would be the disadvantage of distance from laboratory facilities.

The observations on leafless twig/paint brush top support the more extensive ones of Martini (1958).

BANANAS

At the present time the production of bananas for export is of considerable importance to the economy of the S. Cameroons. If present market conditions continue it is expected that African farmers and large estates alike will attempt to increase output of exportable material.

Besides the availability of suitable land, Sigatoka disease and Panama disease are the most important factors limiting banana production at the present time.

Sigatoka disease (Mycosphaerella musicola Leach)

This disease defoliates plants and delays or prevents the formation of the fruit. The size of the finger is affected first and then the number of hands (grade) is reduced. Seemingly good stems may ripen prematurely either on the tree or during transport.

Larter (1937) and Ward (1938a, b) showed that M. musicola could be controlled by regular fungicide application. Leach (1946) demonstrated that spraying effects control of conidial infection but not of ascospore infection. Certain soil conditions were shown to encourage the production of abnormally large numbers of perithecia, giving rise to severe ascospore infection.

On large estates:- The C.D.C. estates at Ekona and Tombel were visited and control measures in operation examined. A large proportion of the total acreage is being contract-sprayed from the air. As little as 7 pints per acre of light oil e.g. Shell E. (spindle oil) applied with rotary cage atomizers was apparently successful. This method of application gives small droplets and reduces the hazards of scorching to a minimum.

At Ekona, where about 3,000 acres of fairly open banana land is not being aerially sprayed, air - blown tower sprayers (Kiekens Dekker Giraffe) drawn by crawler-tractors are in operation. With these machines, fungicide (50% copper as cuprous oxide), is being applied at the rate of 2½ lb/2 gal water per acre, to give good control. Areas inaccessible to the "Giraffe' machines are sprayed with motorised knapsack sprayers (Kiekens Dekker), applying a copper fungicide at about 15 gal/acre.

The cost of these control measures is high. Aerial spraying under contract costs about 15 shillings per acre, including the cost of the oil. The capital outlay for the other methods of spraying is very high so maximum use is made of the machinery and there is an efficient well equipped workshop for its maintenance. The C.D.C. have "Giraffes" which, with crawler-tractors and water-carriers, cost well over £40,000. Six machines are kept in operation while one is kept as a reserve. In order to maintain a 10 hour spraying day with the knapsack sprayers two are being overhauled for each 5 in use. The comparative features of the Kiekens Dekker and Motoblo sprayers were discussed with the staff using and maintaining them.

On smaller native farms:- Sigatoka disease has devastated a large proportion of the native banana crop. In some cases farms are uneconomical after only 2 years. In contrast with the active control measures being applied in the large plantations, as yet no control measures are being applied by the native farmers. Aerial spraying is impossible, even if it could be organized by the Co-operative societies, because the plots are scattered and are interspersed with high forest. The use of power-operated knapsack sprayers, perhaps organized by the Co-operative societies, and of "high-volume" sprayers with long lances needs investigation. Copper fungicides would have to be used with the high volume sprayers and possibly also with motorised knapsack sprayers. Because of the hazards of severe scorching which result from over-spraying, the application of oil with motorised sprayers could not be used, unless suitable modifications can be devised and the operators adequately trained.

Panama disease. (Fusarium oxysporum var. cubense.) (E. F. Smith) Wollenw. and Reinking.

There can be no doubt that Panama disease is spreading northwards from the coast. The banana plantations at Tombel, which still show only slight infection, apparently first became infected along the French side, followed one year later by infection on the British side of the border.

The C.D.C. are interested in the propagation of the variety Lacatan which is very resistant to Fusarium wilt. It has many of the commercial properties of the Gros Michel variety, but there is still some doubt as to the acceptability of this variety to the shippers. Should the planting of Lacatan become widespread, the question of Sigatoka disease control may have to be reinvestigated.

The conidial stage of M. musicola, which is controlled by spraying, is relatively more important on the Gros Michel variety than the ascospore stage which is not controlled by fungicides. With the variety Lacatan however, there is a suggestion that ascospore infection is likely to be more important than it is on the Gros Michel variety, so that the disease may become serious on plantations where it is at present being controlled satisfactorily.

Conclusion

Control measures for Sigatoka disease on African farms need to be investigated. A study of the effects of the inter-action of this disease and Panama disease on the variety of bananas to be grown may also be necessary.

COFFEE

Robusta coffee was seen at the Agricultural Department farm, Barombi Kang, and except for a number of trees which were apparently suffering from an attack of root disease fungus the condition of the trees was generally good. African-owned coffee in the area appeared to be doing reasonably well.

Arabica coffee in the Bamenda area was examined and the condition of the trees found to be very variable. Last season approximately 1,000 tons of Arabica coffee were produced and there is evidently considerable room for expansion of the coffee industry in the area. The following pests and diseases were noted.

INSECT PESTS

Coffee stem borer

On a number of native farms dead and dying trees were often found to be heavily attacked by borers, Entry was at, or below, soil level and although many larvae were found no pupae or adults were seen. It is possible that the insect concerned is *Bixadus sierricola*, although confirmation of this will be difficult as the adult is very short-lived. (Squire 1949). Control measures for this pest will be determined by its severity. Aldrin granules or BHC for soil treatment, and dieldrin paste for stem treatment are possible remedies. This question however, needs further investigation by an entomologist.

Antestia

Well known pests of coffee in other parts of the world are *Antestia lineaticollis* Stal., and *A. faceta* Germ., and evidence suggests that these insects are present also in the Bamenda area. Again control measures need to be examined by an entomologist, bearing in mind the controversy over the control of this pest in East Africa. Haarer ("Modern coffee production") states, "wherever they appear they at once become a major pest of Arabian coffee." It is suggested that Haarer's recommendations should be followed and attempts be made to determine the number of insects per tree in area where they have been found, so that some idea of the nature of the problem can be gained.

Coffee berry borer

Adults and larvae of *Stephanoderes hampei* Ferr. were found to be attacking some coffee berries. The beetle, which is about 1.5 mm long, is indigenous in East Africa where it is said to be unimportant at high altitudes. No control measures are recommended.

Green scale ("Green lice").

Scale insects, possibly *Chionaspis richiei* Laing, were the major pest to be seen at the Santa coffee estate. As yet all attempts to control this insect appear to have failed and the results of the proposed Plant Protection Ltd. trial will be awaited with interest.

Coffee berry disease (Colletotrichum coffeanum Noack) (Glomerella cingulata.) (Stonem.).

Samples of diseased berries collected from the S.I.N.C.O.A. estate (French Cameroons) were found to be infected with Colletotrichum coffeanum. The two types of lesions recorded by various investigators were present. Brock (1956) describes the lesions thus:-

> "Type 1. lesions are actively spreading, sunken brown to black, under favourable conditions producing pink conidial aggregates on the entire surface".
>
> "Type 2. lesions, the so called 'Scab' lesions described by McDonald (1931) are apparently of limited size, slightly sunken, light (buff) coloured with numerous to few minute black erumpent pustules scattered over the surface".

While there can be no doubt about the presence of the 'scab' type of infection it is difficult to say to what extent active lesions were responsible for complete berry blackening because, at the time of the visit conditions were unfavourable for the development of the fungus. Further work at Ibadan is unfortunately not possible, because of the absence of Arabica coffee in the area.

It should be realised that coffee berry disease may become an important factor in the future development of coffee in Bamenda area and a careful watch should be kept on the new Santa estate for possible outbreaks. Without a careful study of the disease it is impossible to make recommendations for its control. Steps taken to promote healthy trees are likely to be beneficial, and, while no conclusions can be drawn as to the possible effect of copper sprays being applied at the S.I.N.C.O.A. estate, these measures should not be discouraged.

Pink disease. (Corticium salmonicolor Berk. and Br.)

Diseased samples collected from native farms in the Bambuie area were all suffering from various stages of pink disease. Generally speaking C. salmonicolor is not a major disease of coffee but should be cut out whenever seen. The fungus develops best in excessively humid conditions where ventilation is poor. The high shade in this area is not too heavy but the thick stands of bananas amongst the coffee are definitely acting as wind breaks. The banana shade should be thinned out. In areas where the disease incidence is high it would be advisable to spray all the trees once with copper (1% Bordeaux or 0.4% Perenox etc.) before cutting-out operations are started. The diseased branches should be cut back considerably beyond the visible extent of the damage and burned. The disease is likely to be spread if infected material is brought into contact with healthy trees or knives used for the cutting-out operations are used to prune healthy trees. Ideally, the knives should be washed in a disinfectant after dealing with each case.

In order that Department of Agriculture field staff may familiarise themselves with the disease symptoms and may prevent outbreaks reaching the serious proportions obtained in the past, the various symptoms are listed below. Any one of these symptoms is indicative of an outbreak.

(1) *Corticium salmonicolor* may be seen on the surface of the smaller branches as pinkish cob-web like "mould".

(2) Discrete pink pustules or a more or less continuous pink incrustation is later formed, usually on the shaded side of the bark.

(3) Orange - red spore pustules may be seen, bursting through the bark, especially on the side exposed to bright light. The pustules are more or less discrete and are usually about 1 - ·2 mm in diameter.

The leaves on the diseased branches dry up and turn brown but usually do not fall. The disease may spread to the berries.

Leaf rust (Hemileia vastatrix Berk. and Br.)

At the time of the visit very little leaf rust was seen. On Arabica coffee this disease can be serious at the lower elevations where the humidity and temperature are more suitable for the development of the disease than at altitudes between 5,000 - 7,000 ft. The economics of spraying copper fungicides for the control of this disease in the Cameroons need careful investigation. It is quite likely that the planting of a resistant variety would alleviate the necessity to spray.

YAMS

Yam disease

The diseased specimens collected from the Department of Agriculture farm at Bafang were found to be infected with Bagnisiopsis dioscereae Wakef. The disease is not an important one but since the samples were taken from a variety trial a record should be made of possible susceptible varieties.

Helminthiasis Research

One of the breeding sites at Kumba treated with insecticide to control Chrysops larvae was visited. The significance of the analytical results so far reported on the mud samples analysed at Arusha were then discussed. Bioassays on samples taken at intervals after the application of dieldrin emulsion have suggested that after about six months the concentration of insecticide in the mud is marginal for Chrysops control. The corresponding chemical determinations will be very significant.

ACKNOWLEDGEMENTS

The authors wish to thank all who helped to make their visit proceed smoothly, in particular Mr. D. G. M. Hutchinson, the Principal Agricultural Officer, S, Cameroons; Mr. J. West, Chief Research Officer, C.D.C., and Mr. O. E. K. Laband, Manager at the Cadbury and Fry estate. Helminthiasis Research Unit kindly supplied lodging in the Kumba area, whilst Mr. T. S. Jervis and Mr. R. E. G. Burnley (A.O.) were responsible for the visits to coffee farms in the Bamenda area.

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NEWS ITEMS - GENERAL

DIETHYLTOLUAMIDE

Chronic toxicity studies being conducted by the United States Army Environmental Health Laboratory on diethyltoluamide have recently shown kidney damage in experimental animals.

Other studies with radioactive labelled diethyltoluamide indicate that diethyltoluamide is metabolized in the body and that the products of metabolism are excreted in the urine. It is assumed the damage to the kidneys may be caused by the products of metabolism.

In view of this the Surgeon General, United States Army, has recommended that diethyltoluamide should not be used by the U.S. Army as an insect repellent until further studies of chronic toxicity have been completed and that M-2020[*] should continue to be used by the U.S. Army as an insect repellent.

(Canada Department of Agriculture, Insecticide Newsletter, Ottawa, 1960, 9, (2).)

USE OF PESTICIDES IN AGRICULTURE

A Panel of Experts met in Rome, Italy, 6-13 April, 1959, to consider the use of pesticides in agriculture. The meeting was convened by the Director-General of F.A.O., Mr. B.R. Sen, in pursuance of the recommendations of the European Commission on agriculture and other technical groups. The following experts and FAO staff participated:

Dr. Maria Alessandrini
Dr. Simone van den Bruel-Dormal
Dr. H.L. Haller
Dr. Henry Hurtig
Dr. E.J. Miller
Dr. Horst Mueller
Dr. Clemens Zach
Dr. J.G. Knoll
Dr. Lee Ling
Dr. C. Logothetis

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[*] This consists of dimethyl phthalate 40%, 2-ethyl-1, 3-hexanediol 30%, and dimethyl carbate 30%.

Proceedings

The Panel recognised that there was a growing need to reduce crop losses, and thus to conserve food supplies, by the use of pesticides and other effective means. It encouraged further careful examination of the criteria governing the efficient use of pesticides including the matter of residues. It stressed the need for the safe usage of pesticides and recognised as the responsibility of Industry the requirement (1) to safeguard its workers engaged in the manufacture and formulation of pesticides, and (2) to ensure that users of its products are properly informed of the correct manner of use and of precautions to be observed. A form of labelling and the type of data required in support of labelling claims have been indicated.

It placed on Authorities the major responsibility for the safe use of pesticides since "they are in a position to lay down the conditions under which a pesticide, imported or manufactured locally, is formulated, packed, transported and sold, and to ensure that the products are made available to users only in an appropriate and suitable form of packing which is adequately labelled and that the claims made on the label for efficacy and safety in use are true. They are in a position to insist that all claims on the label are supported by adequate data. According to the facilities available in their country, the authorities may themselves evaluate those data or request the assistance of others, including intergovernmental organisations, to undertake this evaluation.

When the distributors are unable to meet government requirements for data on effectiveness and residue of the pesticides on crops grown in the country, the authorities may undertake to assist in obtaining the necessary information.

The authorities should be prepared to take rapid and effective action against distributors violating any regulations or agreements on the importation or manufacture and sale of pesticides and against users for the misuse of these products.

Finally authorities should take all possible steps to instruct the industry and users in the safety aspects of pesticide manufacture and use by the provision of an official advisory or extension service."

The report adds "The user of a pesticide has a moral responsibility to meet the requirements of the authorities and the instructions of distributors with regard to the safe and proper use of the product."

The Panel realised that further attention should be given to the side effects arising from the use of pesticides.

On the matter of public relations the Panel disparaged the degree of publicity accorded alarmist and un-uniformed attacks on the strategic use of pesticides and considered that "It would be in the best interest of all if these controversial matters could be resolved by recognized competent scientists in authoritative national or international forums in which the interests of agriculture and public health could be harmonized. Another important step is the dissemination to the public of adequate information on the precautionary methods now employed to protect their interest".

Conclusions and Recommendations

Having considered various aspects relating to the use of pesticides in agriculture, the Panel concluded and recommended as follows:

1. Although it is generally recognized that the losses caused by pests are enormous, the Panel considered that true losses can only be assessed through the development of quantitative statistically sound methods.

2. Although pesticides are necessary in the commercial production of adequate food supplies, they may be harmful when used improperly. The Panel therefore recommended that research be initiated or intensified on:

(a) the effects of pesticides on crop quality; and

(b) the effects of repeated application of pesticides on soil microorganisms and soil fertility.

The Panel further recommended that FAO

(a) take the initiative in accumulating and disseminating information on the effects of pesticides on wildlife; and

(b) urge authorities responsible for the execution of large scale pest control operations to seek the co-operation of fish and wildlife conservation officials in the planning stage of operations in order to keep losses to a minimum.

3. Although adequate control of many pests is possible today, the Panel was of the opinion that in many instances costs may be reduced, efficiency increased, residue levels controlled and the incidence of resistance to pesticides minimized with further study. Therefore the Panel recommended the research be initiated or intensified on:

(a) the variation in response to pesticides that can be expected in normal, naturally occurring populations of economic species of insects prior to application of pesticides and after repeated application of pesticides;

(b) the improvement of spray application techniques with the elucidation of principles governing dispersal and deposition, in order to obtain maximum amount of coverage and protection with minimum amounts of pesticides;

(c) the determination of the optimum state of pesticide deposits and the principles governing the physico-chemical and biological relationships that determine the formation and efficiency of deposits; such studies would lead to the development of better formulations with more predictable performance;

(d) the manner in which various components of a pesticide formulation can be varied in order to produce predictable residue levels; and

(e) the elucidation of the principles of residue metabolism and decay in and on food plants during growth especially in order to reduce the present extensive requirements for the determination of residues at harvest.

4. The Panel recommended that for the efficient use of pesticides precise information on the life history and habits of the pest species to be controlled be made available. Similar information on its parasites and predators is needed so that pesticide application may be made when maximum benefits can be obtained with the minimum destruction of the population of beneficial insects. Furthermore the Panel recommended that governments initiate or intensify research which will lead to the harmonizing of chemical and biological control practice.

5. The Panel considered the problem of pesticide residues and recommended that:

(a) governments be urged, when setting up bodies to advise on regulations designed to control pesticide residue levels, to include in those bodies, in addition to public health authorities, agricultural pesticide and plant and animal protection interests; and

(b) governments be urged to adopt, as a minimum, the requirement concerning labelling as suggested in this report.

6. As the validity of residue data greatly depends on the adequacy (sensitivity, reproducibility, specificity etc.) of the analytical methods used, the Panel recommended that studies be intensified on problems involved in the analysis of pesticide residues in or on foodstuffs.

7. Because the proper and safe use of pesticides is of common concern to agricultural, public health, wild life and veterinary authorities, the Panel recommended that studies be undertaken jointly by FAO and WHO on;

(a) the hazards to consumers arising from pesticide residues in and on food and feedstuffs;

(b) the establishment of principles governing the setting up of pesticide tolerances;

(c) the feasibility of preparing an International Code for toxicological and residue data required in achieving the safe use of a pesticide;

(d) ways and means of disseminating to the public adequate information on precautionary measures now employed to protect comsumer interests.

8. The Panel complimented FAO in taking an active interest in agricultural pesticides and for undertaking a study of the problems arising from their use. In view of the importance of modern pesticides in the production of adequate supply of agricultural commodities for a rapidly growing world population, the Panel urged FAO to continue its interest in the study of the use of pesticides in agriculture.

(Report of the FAO Panel of Experts on the Use of Pesticides in Agriculture held in Rome, 6-13 April, 1959.)

INSECT RESISTANCE

1. Agriculture

"Development of strains resistant to pesticides by an increasing number of insects and mites has become a serious problem in control of orchard pests. Strains of the European red mite resistant to parathion, malathion and a number of other organic phosphates are now widespread in the Okanagan Valley of British Columbia and the Niagara Peninsula of Ontario. Recently, strains of this mite resistant to ovex developed in parts of British Columbia, Ontario, and Nova Scotia. in British Columbia ovex-resistant mites were also resistant to fenson (Murvesco) and in Nova Scotia to fenson and elimite. The discovery of DDT-resistant strains of the codling moth in many orchards in British Columbia was the most serious development in 1958. Larvae from an orchard where control had become particularly difficult were about 50 times as hard to kill with DDT as those from an orchard where little or no DDT had been used. Very heavy infestations of the moth in two well-sprayed orchards in Ontario in 1958 almost certainly indicated resistant strains in that province also. A third pest that has apparently developed resistant strains is the pear psylla; in previous years malathion and parathion provided excellent control, but in 1958 these insecticides were almost useless in a number of orchards in the Okanagan Valley."

(Report of the Minister of Agriculture for Canada for the Year ended March 31, 1959.)

2. Public Health

"The threat from disease-carrying insects resistant to insecticides continues to grow. Eight years ago we stated in an annotation (1) that despite extensive use of DDT for some six years there was very little evidence of resistance, the best authenticated cases being "one or two species of culicine mosquitoes and the housefly." By 1955

⁎ Note: Pesticide designations used in the above extract conform to the recommendations of the Entomological Society of America.

resistance had been definitely proved in 18 species of public-health importance and was suspected in 19 others; and now it seems that "the only genera in the field of medical entomology for which resistance has not yet been reported are Simulium, Phlebotomus, and Glossina." (2) Furthermore, resistance may prove more harmful in the future than it is now, because in nearly every case so far resistance has developed to one type of insecticide only, so that it is still possible to control the pests concerned with an alternative. But there are not many alternatives: indeed, the new synthetic compounds with long-lasting contact action fall into only two classes - DDT plus its analogues and the gamma-benzene-hexachloride-dieldrin group. A few pests, such as the housefly, the bed bug, and one or two types of mosquitoes, have developed double resistance. Public-health workers have to destroy these with the organo-phosphorus compounds or pyrethrins, which do not have the same convenient residual properties.

About three years ago the World Health Organization, taking account of the seriousness of the situation, began to institute countermeasures through its expert committees (3). An experienced biologist was required to co-ordinate the exchange of information, and this post has been filled on a temporary basis by experts seconded from different countries. Professor A.W.A. Brown, of Canada, was appointed for the first two years, and from his experience during this period he has prepared a review (2) of insecticide resistance. There were already about 40 reviews in print, but none approaches the comprehensiveness of this one, which runs to 240 pages and which draws on some 650 scientific papers published up to mid-1957. The data have been selected and arranged with two kinds of reader in mind - the public-health administrator, who wants all the relevant information on a particular pest in order to decide on the most feasible measures of control, and the research worker, who requires a full analysis of previous research.

It is difficult to see the best way of countering the threat of insecticide resistance. No way has yet been found of restoring its former efficiency to an insecticide against which a pest has developed resistance. The best hope seems to lie in preventing the development of resistance, perhaps by mixing insecticides. Although this does not seem promising in laboratory tests, it is a method which has not yet been sufficiently explored in the field. One hopeful sign is that susceptibility to certain poisons seems to be linked with resistance to orthodox insecticides: theoretically these poisons could destroy resistant strains as they emerge. Meanwhile, until research provides the answer to this problem, insecticides should be used in ways most likely to eliminate specific diseases before resistance develops in the vector."

(1) Brit. Med. J., 1951, 2, 900.
(2) Brown, A.W.A., "Insecticide Resistance in Arthropods", World Health Organization, Monograph No.38, 1958, Geneva.
(3) Brit. Med. J., 1956, 2, 1155.

(British Medical Journal, 19th Sept, 1959, pp.485-6)
We are indebted to the Editor of the British Medical Journal for permission to reproduce the above annotation.

DESERT LOCUST CONTROL

FAO Panel of Experts on the Use of Aircraft for Desert Locust Control

"Following the recommendations of the Eighth Session of the FAO Technical Advisory Committee on Desert Locust Control, the Director-General of FAO convened a panel of experts in Rome during April 1959 to consider the present status of aircraft methods of desert locust control and reconnaissance and to indicate lines along which further developments appeared particularly promising.

A review of the current situation showed that during the last five years at least 23 countries and territories have used a considerable variety of aircraft for various aspects of desert locust control, and that most national antilocust services had some experience in aircraft operations against the desert locust.

The insecticides most widely applied from aircraft were BHC, aldrin, dieldrin and DNC but promising results were reported with several others, notably diazinon and malathion. Spraying was virtually the only method now used for applying insecticides against the desert locust, dusting and baiting having been almost entirely abandoned. Best results were obtained when insecticides were applied in oil solutions and, for economic reasons, high concentrations were required. Insecticides were applied against egg-fields, hopper bands and settled and flying swarms. Experience showed that highly concentrated insecticides did not present any undue hazards to operators. No authentic case of serious injury to man or domestic animals resulting from deposits of insecticides on vegetation was known and phytotoxic effects could be avoided by applying fine droplets.

The Panel emphasized the value of aircraft for locust swarm reconnaissance. Swarms had been regularly sighted at distances up to 100 kilometers, and effective rates of search of 9,000 square kilometers per hour had been obtained repeatedly.

Experience in a number of areas has demonstrated that both for control and reconnaissance, aircraft have achieved results unobtainable by other methods, and that the cost of aircraft operations compare favourably, in terms of results achieved, with those of other control practices. Nevertheless, practically nowhere was full use being made of the potentialities of aircraft methods although it was evident that the present scale of over-all control operations fell far short of that demanded by the magnitude of the locust problem. It was further recognized that aircraft alone promise to provide the necessary increase control potential, that they offer the best opportunities for international co-operation, and that they could be the most effective form of regional strategic reserve.

In considering the further development of the use of aircraft in desert locust control, the Panel emphasized the need for interterritorial co-operation and it recommended that governments, in building up their national aircraft units, should plan not only on a national but on an interterritorial basis, so that maximum control effort could be concentrated where most required. The Panel studied the need and practicability of establishing an international antilocust aircraft unit, which it believed would constitute a most useful mobile strategic reserve in the control of the desert locust.

In the past, aircraft spraying had been used mainly as a last line of defence. It was now appreciated that swarms of the desert locust appear always to be present somewhere, and that the species was thus not intermittently but continuously vulnerable to attack by just that method of control which alone could match the locust's mobility.

However, the Panel recognized that, particularly as regards strategy, the use of aircraft against the desert locust differs greatly from their use against other locusts or grasshoppers and from crop spraying practice. Successful operations for control reconnaissance requires sound organization and skilled personnel with appropriate experience.

FAO Panel of Experts on the Strategy of Desert Locust Plague Control

In accordance with the views expressed by the Twenty-ninth Session of the FAO Council, the Director-General of FAO convened a panel of experts in Rome from 27 April to 1 May 1959, to advise on the most appropriate and effective manner in which FAO might apply its resources for desert locust plague control.

In 1956 FAO Panel of Experts on Long-Term Policy of Desert Locust Control (Ref. FAO Plant Prot. Bull. 4: 145-147. 1956) reviewed the general and seasonal distribution of desert locust swarm breeding areas and the major swarm movements connecting them. On the basis of data made available by the Anti-Locust Research Centre, London, the recent panel brought this review of plague dynamics up to date.

Although the desert locust invades some 30 million square kilometers of Africa and south-western Asia, the area in which it breeds covers only some 13 million square kilometers. Furthermore, breeding is more frequent in some parts of that area than in others, so that high-frequency breeding areas occupy a still smaller portion of the total invasion region.

The Panel stressed the importance of these high-frequency breeding areas, the causes of which remain undetermined, though they are being studied by the FAO/UNESCO Desert Locust Ecological Survey and others.

Two great zones of seasonal breeding were recognized, one during the first half of the year, the other during the second, with the main breeding occurring in different sections of the invasion region during alternate seasons.

In relation to control, it was noted that a large proportion of the 61 countries and territories subject to desert locust invasions would escape attack if control measures were effective in major swarm-producing areas in the more central part of the locusts' distribution region.

The analysis of the seasonal positions where swarm and hopper infestations were most frequent showed that during the July-September quarter, both swarm and hopper infestations become confined to a relatively restricted belt, even at the height of a plague. This season and belt might thus be expected to provide opportunities for concentrated control operations, which could have far-reaching effects on the course of the plague.

It was clear that fully effective desert locust control was not being achieved by present strategy, in which the major effect, on a national basis, was made when the plague was widest spread, while only limited local forces were available when the plague was concentrated in a confined region. The Panel was convinced that, even with the present level of annual expenditure, control operations could be greatly improved, provided that correct methods and rational strategy were universally adopted. This necessitated treating the total invasion region as a whole and changing the over-all policy from defence to offence, concentrating control where and when it could achieve the greatest impact on the over-all situation during plague activity and during recession periods.

The Panel proceeded to indicate how best the principles it had enumerated could be adopted to develop a more rational strategy through international, regional and national action.

Among other points, the Panel emphasized that the success of the proposed strategy depended on reliable and up-to-date information on the current locust situation throughout the invasion region, requiring a general strengthening of information, reporting and forecasting services, and that there was a universal shortage of properly trained and experienced personnel in all aspects and levels of desert locust control, resulting in inefficiency and waste.

Finally the Panel stressed its view that though the proposed new strategic approach to desert locust control offered definite hope of subduing the current plague, it alone was not expected to prevent the recurrence of future plagues. This strategic approach would, however, contribute to achieving such prevention along the lines stated by the 1956 Expert Panel on the Long-Term Policy of Desert Locust Control, which has emphasized that further progress toward prevention of future desert locust plagues required intensified research and investigation. This view was strongly endorsed by the recent panel."

(F.A.O. Plant Protection Bulletin, Aug.1959, 7, (11), 150-152.)

COMMONWEALTH AGRICULTURAL BUREAUX
30TH ANNUAL REPORT OF THE EXECUTIVE COUNCIL 1958-59.

London, H.M.S.O., 1959, 48 pp.

The following items on pest control are conned from the Directors' Notes of Progress in the Agricultural Sciences.

Mycology and Plant Pathology

Practical success has been obtained by the use of antibiotics and antimetabolites such as streptomycin and thiouracil in the control or eradication among other diseases of cherry canker and silver disease of beet in the United Kingdom, bacterial blight of beans in Australasia, bacterial canker of olive in Italy, bacterial diseases and mosaic virus disease of tobacco, and virus diseases of stone fruit trees in the United States, whilst a reduction of initial infection with bacterial blight of cotton below the level which gives significant increases in yield has been obtained by G.M. Wickens in Uganda by the use of mercurial seed dressings.

Eradicant sprays such as phenyl mercury compounds and DNOC have shown increasing success against apple scab and are rapidly replacing protective sprays, whilst it appears that the very damaging coffee disease in Kenya may eventually respond to mercury.

The problem of the control of virus diseases, however, still remains, but there have been several important steps forward. Heat therapy of planting material is now in general use and successful control of, for example, ratoon stunting disease of sugar cane has been accomplished in many countries.

Veterinary Science

Another considerable advance concerned an arthropod parasite, namely the warble fly, the larvae of which cause severe damage to hides in many parts of the world. In the past control has depended upon hand dressing the skins of affected cattle with preparations containing derris. The dressings killed the larvae and their continued use could greatly reduce the warble fly population but their application was time-consuming and expensive in labour. A number of organo-phosphorus compounds has been developed in Amercia and Germany, some of which can be administered by the mouth. These "systematic parasiticides" kill the fly larvae at an early stage of their development before they reach and damage the hides. In laboratory and field trials it has been demonstrated that one dose administered in the summer causes a dramatic decrease in the number of warbles which develop in the hide in the following spring. The drugs in addition to being efficient against the warbles caused by *Hypoderma* spp. in temperate zone countries have also been found effective against *Dermatobia hominis* which is a problem in South America.

These drugs are potentially toxic and fears of poisoning in man by residues in the meat and/or milk of treated cattle have led to a close study of the question. In the U.S.A. the authorities have approved their use in beef cattle provided the treated cattle are not slaughtered before at least six weeks have elapsed from the time of treatment. The use of the drugs in dairy cows is not permitted.

Pastures and Field Crops

Notable progress has been made in the development and use of new selective herbicides, e.g., the notorious water hyacinth which when uncontrolled rapidly blocks irrigation canals and other waterways in the tropics can now be controlled by spraying with herbicides such as 2,4-D and 2,4,5-T. Another serious weed pest, couch grass, can now be controlled by dalapon and there are indications that a successful herbicide has at last been discovered for bracken.

GRAIN STORAGE

We reproduce below an open letter from Dr. T.M. Dobrovsky, appearing in the first number of Grain Storage Newsletter, a news bulletin issued by Crop Protection Branch, Plant Production and Protection Division, Food and Agriculture Organisation of the United Nations, Rome, Italy.

"This issue introduces the FAO Grain Storage Newsletter which will from time to time bring you news and information. It will be an informal communication addressed to personnel throughout the world engaged in research, training, or regulatory work concerned with the reduction of losses in stored grains and other stored foodstuffs. As the name of our publication indicates, the emphasis will be on cereals. We are embarking upon this venture with ambitious plans in the hope of rendering the following types of service:

1. Furnishing information on existing facilities in various countries for research and training in the field of grain storage.

2. Disseminating results of investigations in the form of summaries or abstracts of publications.

3. Facilitating interchange of research programs between institutes in different countries.

4. Highlighting practical new techniques designed to prevent or reduce losses in stored grains and to prevent the dissemination of storage pests.

5. Facilitating contacts among workers in the field of grain storage.

6. Circulating information on current or prospective events of interest to workers on our field.

The extent to which we succeed in carrying out this program will depend as much on our efforts here in Rome as on your interest and co-operation. We, therefore, invite contributions along the following lines:

A. From Institutes:

1. Brief description of your facilities for research and/or training in grain storage problems.

2. Lists of your current investigations and future programs of work, with brief explanations.

3. Reprints and/or abstracts of recent publications.

4. Names of administrative and research personnel dealing with grain storage.

5. The most pressing needs (if any) of your institutes.

B. From regulatory and/or infestation control agencies:

1. Administrative structure of your agency, and names of personnel in charge.

2. Methods (standard and/or new) applied in your country for the prevention of losses of grains in storage and in transit (including treatments in ships).

3. Legislation concerned with:

   a. control of infestation of grains in storage and in transit (including imports and/or exports)

   b. poison residues in stored grains.

4. Methods and facilities for training of personnel.

C. From all readers:

1. Announcements of current or prospective events and occurrences in your institute, agency or in your country as a whole, including meetings, training courses, new legislation, changes in personnel, new pests, etc.

2. A special appeal is made for English abstracts of papers published in any language, in any part of the world.

While the requested contributions may appear to cover a large number of items whose preparation may tax your time heavily, please note that we:

> do not require all the above information in your first communication,
>
> do not request long articles,
>
> do not expect immediate response from everyone,

even though we shall not refuse to accept gratefully immediate contributions covering the entire field! A convenient procedure, we might suggest, is that you write up one or more items each month and send them in promptly. The more concise and clear your contributions, the less editing they will require, therefore, the more issues will reach you each year. But we shall be much happier receiving elaborate and rambling material than none at all.

And now, may I remind you, wherever you may be, that we are engaged in a struggle to increase the amount of food available to mankind The cheapest and fastest method of accomplishing that is not by increasing production, but by reducing losses. We in this field know if losses were eliminated, there would be over 55,000,000 metric tons * of additional grains available each year without increasing production by a single kilogram. That is enough to supply the carbohydrate needs of more than 250,000,000 people for one year. To what extent are your governments aware of this fact? The information and help which we can furnish each other through this Newsletter will strengthen our common effort, so that more people can have more food".

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* This figure is based on world production estimates (U.S.S.R. not included) and on an estimated average of 10 per cent annual loss in stored grains.

NEWS ITEMS FROM THE COMMONWEALTH

AUSTRALIA

Snail Control: Comparisons have been made of the molluscicides copper pentachlorophenate (CPCP) and bluestone (copper sulphate) against *Simlimnea subaquatilis*, the common intermediate host of liver fluke in Australia.

"In preliminary experiments, powdered CPCP was applied to infested pastures with a knapsack duster or a superphosphate blower. Although it killed the snails, the dust was very irritating to the skin and eyes, and other ways of applying CPCP had to be found. A dispersible powder was next tried, but it did not mix readily enough with the water and caused irritation during mixing.

Finally, a greatly improved preparation was developed that was used in all the main trials. This was a 30% dispersible paste packed in a double polythene bag in a 4-gallon metal drum. The paste is easy to measure by volume and it mixes readily with water."

The concentration used was 10 lb CPCP paste in 400 gallons of water. The rate of application was eventually standardised at 400 gallons per acre. This high-volume spraying of CPCP was far more efficient than the usual technique of broacasting, and applied also to bluestone.

In one trial 13.7 lb CPCP per acre was needed for a 90% kill of snails in 24 hours compared with 19.1 lb of bluestone. In another trial to assess the long-term effects, treatments were 10 lb per acre of CPCP paste in 1000 gallons of water and 20 lb per acre of bluestone also in 400 gallons of water; both were applied by means of a portable boom sprayer. CPCP gave an immediate complete kill of snails whereas some snails survived the bluestone treatment, and after 3½ months the only snails found in the CPCP-treated area were confined to a small section near a spring head, whereas on the bluestone-treated land the snails had multiplied so rapidly that the entire area had to be re-sprayed.

In a further trial a specially designed lance was used to inject the molluscicide deep into soft mud - previously a safe refuge for snails.

"Although CPCP is much more efficient than bluestone, it is more expensive and few stock-owners have been prepared to buy it. The preparation has therefore been withdrawn from the market. The sodium compound, however, which is also a very good molluscicide, is less expensive than bluestone and is readily available. Its only disadvantage is that it may be irritating to the operators. But there is no danger provided reasonable care is taken. Sodium pentachlorophenate is applied in the same way and at the same rate as CPCP."

("Fluke Control - New Ways of Killing Snails." Rural Research in C.S.I.R.O., Dec. 1959, No.9, 13-17.)

AUSTRALIA - QUEENSLAND

Deciduous Fruits: Orchard trials have shown that DDT is still the best insecticide for the control of codling moth, Cydia pomonella L. and that the inclusion of some of the newer materials in future programme trials is warranted.

Lucerne: It is reported that in two areas, spraying against leaf roller, Tortrix divulsana Walk. was somewhat ineffective until white oil was added to the DDD.

Peanuts: Work on the control of crown rot, Aspergillus niger, in peanuts was continued and during the season four field trials were planted with this object in view. The results were similar to those obtained the previous year and confirmed the superiority of a seed dressing consisting of a mixture of an organo-mercurial compound and captan.

Stem rot caused by Sclerotium rolfsii was of wide spread occurrence but serious losses were not numerous. The primary effect of the disease is to cause the peanuts to rot off the peg, leaving them in the ground at pulling time. Leaf-fall following leaf spot accentuates the damage and the mycelium of S.rolfsii could be seen growing throughout the fallen leaves at the base of the plant. In a field trial comparing the effect of hilling, not hilling and treatment with pentachloronitrobenzene, the yields were slightly in favour of the use of P.C.N.B. The economics of this method of control would need careful consideration.

Tobacco: Because of the low intensity of infection the reduction in leaf-mould damage was not particularly striking, nor was it possible to determine whether the additives made any difference to the loss in efficiency associated with zineb alone under epidemic conditions. However, the combination spray at both schedules reduced stem-mould infection to negligible proportions and was definitely superior to zineb alone for leaf-mould control. Leaf which had been consistently sprayed with the zineb-cottonseed oil-methyl salicylate mixture broke down on curing and it becomes necessary to investigate this aspect of the problem further.

Ginger: At Nambour a ginger rhizome rot experiment was concluded. Various dilutions and times of immersion of a standard mercurial containing 6% mercury were compared as a seed-piece dip. Increasing concentration and time of immersion gave better control of rhizome rot (*Fusarium oxysporum*) up to the point where abnormal shooting occurred. The best combination to use is probably 2 lb in 40 gal for 10 min. This will speed up operations compared with the present recommendation of a 30-min. dip using half this strength.

Stone Fruits; In Stanthorpe, two brown rot (*Sclerotinia fructicola*) experiments were concluded. It would appear from a spraying trial that fortnightly or weekly sprays of captan over the month prior to harvest and ending with one immediately prior to picking will reduce the rot very considerably.

Banana: Following the demonstration of the efficiency of oil sprays for the control of leaf spot (*Cercospora musae*), an attempt was made to ascertain the part played by the oil in this control. White oil emulsion in itself is not toxic to the fungus, yet applications to the leaf either before or after inoculation will prevent infection. A field trial is under way to decide the usefulness of misting and fogging techniques for leaf spot and speckle control under northern conditions.

After many years, the pathogenicity of the fungus which has been associated with the cause of leaf speckle in bananas in Queensland has been satisfactorily proven. This organism is a *Mycosphaerella*, probably *M.musae* (Speg.) Sydow. The control of this disease has been investigated in conjunction with the work on leaf spot. Oil alone is not as efficient a fungicide with speckle as it is with the latter. Moreover, more attention has to be given to maintaining a cover on the older leaves of the plant if adequate control of leaf speckle is to be obtained.

(Department of Agriculture and Stock, Annual Report 1958-59)

Sugar

Cane Grub Control (Lepidiota frenchi and L. consobrina): In trials against grubs in the Bundaberg district it was observed that, on light sandy forest soils, the ploughing-in of 20% crude BHC dust in amounts in excess of 150 lb per acre, or shallow discing-in of 600 lb per acre, caused a noticeable and persistent depression of growth; and amounts in excess of 75 lb per acre applied at planting time above the lightly covered setts caused a temporary loss of vigour in the plant crop but not in subsequent ratoons. Should heavy applications such as these prove necessary, it can be expected that the use of lindane will avoid these phytotoxic effects. In a phytotoxicity experiment conducted in pots, lindane at a concentration of eight parts per million, caused no detectable depression of root growth from single-bud setts, in a nine week period, but an equal concentration of gamma BHC, in the form of crude BHC, reduced the mean weight of roots per sett from 4.2 g in untreated soil to 0.5 g in the treated soil.

Chrysomelid Beetle, Rhyparida dimidiata, Control: In field trials, gamma BHC as crude BHC dust, was applied (1) at rates of 2, 4 and 8 lb per acre broadcast, half the amount before the final ploughing, and the remainder before a subsequent discing, and (2) at 1, 2, and 4 lb per acre at planting time, in a band above the lightly covered setts, before full cover was applied. Aldrin was similarly applied at 4 lb per acre broadcast and 2 lb per acre at planting time. The infestation in the broadcast section was considerable, and the benefit of the insecticides became apparent at an early stage of growth; but in the drill treatment area the infestation was insufficient to provide significant results. When broadcast, 2 lb of gamma BHC per acre caused an increase of 7.6 tons per acre as compared with the yield from untreated plots, that difference being significant at the 5% level; increases of 9.3 and 10.5 tons per acre obtained by broadcasting 4 lb and 8 lb of gamma BHC per acre respectively, and of 9.2 tons per acre by broadcasting 4 lb of aldrin per acre, were all significant at the 1% level.

Funnel Ant, Aphaenogaster pythia Forel: Although in recent years significant increases in yields in field trials have frequently, but not always, resulted from the use of soil insecticides, particularly aldrin and BHC, no one insecticide or method of application has been consistently superior, and none of the treatments has markedly diminished the ant infestation. However, in exploratory plots set out in 1958, in which short-range economics were disregarded, aldrin and gamma BHC at 20 lb per acre, and chlordane at 40 lb per acre, were broadcast and disced, ploughed, and double disced into a sandy loam, prior to planting. The aldrin and chlordane completely inhibited mound building and eliminated the ants, not only from the treated areas but also in a downhill direction along the rows, from 30 feet of guard space that intervened between the plots. The BHC treatment allowed a considerable survival of ants. Further trials are being conducted to reduce these heavy applications to economic proportions, and other insecticides and methods of application are being tested. In a laboratory screening test heptachlor, aldrin, and "Korlan" were mixed with soil at concentrations of 1, 2, 4 and 8 parts per million, and thirty asexual ants placed in each of three replicate containers. Heptachlor and aldrin were equally effective, causing complete mortality in six days or less in all concentrations, but "Korlan" was less so, and "Asuntol", "Neguvon", and malathion had little or no effect; diazinon was highly toxic, causing complete mortality in two days at 1 p.p.m.: lindane caused complete mortality in five days at 1 p.p.m. In laboratory tests diazinon, dissolved in sugar solution and stabilised on bran or sawdust, had proved a readily accepted and highly lethal poison bait, but in the field a single laying of bait killed only a small proportion of the ants. The lack of surface activity by the ants in dry weather, and the perishability of the bait in wet weather, were incompatibles which presented obstacles to the practical application of baiting.

Soldier Fly, *Metoponia rubriceps* Macquart.: In screening tests of soil insecticides, larvae ranging from 3 to 10 mm in length, were placed in pots of soil with pieces of cane to which they soon attached themselves. Aldrin, dieldrin, DDT, chlordane, lindane, and malathion were mixed with this soil at concentrations of 2, 8 and 16 p.p.m. During a three-week period mortalities were negligible; at five weeks the following percentage mortalities had taken place in the 2, 8 and 16 p.p.m. concentrations respectively: aldrin 12, 48, 56; dieldrin 4, 12, 44; lindane, 0, 32, 68. Death took place more readily amongst the smaller larvae. After 12 weeks, 100% mortality had occurred only in aldrin and lindane at 16 p.p.m., that in dieldrin at 16 p.p.m. being 83%. The results with the other insecticides were markedly inferior.

Earth Pearls (Margarodidae): Exploratory screening tests of soil insecticides in 1956 against the encysted stage did not give encouraging results. In 1957, five females were allowed to oviposit in each pot of untreated and treated soil so that the thinly-integumented, mobile, young larvae would encounter any insecticide present. Cane roots were provided by setts planted in the pots two months before the females were introduced. The insecticides used, and their concentrations, are shown in the table, in which is set out the total number of cysts of Eumargarodes laingi Jakubski, that developed in the five replicates of each treatment. Parathion was highly effective, preventing earth pearl development at all concentrations used, and dieldrin gave a high degree of control, at all concentrations. As parathion is not reputed for persistence in the soil, dieldrin might prove more effective over the three-year crop cycle.

Total Numbers of Earth Pearls of E.laingi
Surviving Various Treatments

Treatment	Total Cysts in Each Concentration					
	32 p.p.m.	16 p.p.m.	8 p.p.m.	4 p.p.m.	2 p.p.m.	1 p.p.m.
Parathion	0	0	0	0	0	0
Dieldrin	0	1	0	2	3	0
Aldrin	0	2	80	214	22	124
Endrin	1	1	69	127	128	43
BHC	2	21	92	76	78	21
DDT	7	0	74	61	44	50
Chlordane	16	236	125	78	129	151
Control	193					

(59th Annual Report of the Bureau of the Sugar Experiment Stations, Brisbane, 1959.)

AUSTRALIA - SOUTH

San José Scale, Quadraspidiotus perniciosus, Control: "The discovery of San José scale in a number of orchards on the lower Murray last year was followed by an intensive campaign aimed at eradicating the pest."

"Winter and summer treatments are both effective in controlling San José scale; but it is virtually impossible to eliminate the pest in one season, because scales harbouring under loose bark and lichens are protected from contact with the sprays. Systemic insecticides have not proved effective; oils and organic phosphates are the best sprays used thus far. It is essential to wet all parts of the tree very thoroughly."

Spray recommendations for all deciduous trees except apricots (which must never be sprayed with lime sulphur) are:

(1) Winter Treatment:

"(a) Lime sulphur 10 gallons in 100 gallons water; or

(b) Superior dormant oil 3 gallons in 100 gallons water.

The oil spray may be improved by the addition of parathion at 0.025%, i.e. 8 fl.oz 50% concentrate, or "Gusathion" at 0.05%, i.e. 2 lb 25% w.p. in 100 gallons.

Apples and pears may receive semi-dormant oil 1 gallon and lime sulphur 5 gallons in 100 gallons water up to bud swell stage. Only a grade of oil which will mix with lime sulphur should be used for this purpose. For peaches, nectarines and cherries DDT-oil at 1 gallon in 40 gallons water to 1 gallon in 60 gallons water, according to brand, may be used for combined Aphis and San José scale control at bud swell stage.

Damage may result in some varieties if more than two dormant oil sprays are applied in the same season or if dormant oil is used after bud swell".

Summer Treatment:" A post-harvest spray of summer superior or white oil at 1¼ gallons in 100 gallons water, combined with parathion at 8 oz 50% concentrate or "Gusathion" at 2 lb 25% w.p. will help keep the scale in check. Both these materials are superior to malathion."

("San José Scale." D.T.Kilpatrick. Journal of Agriculture, South Australia, Dec. 1959, 63, (5), 208-210.)

Bryobia mite control: In South Australia the Bryobia mite, Bryobia praetiosa attacks apple, pear, almond, plum, prune, apricot and peach trees. It can also infest clover, lucerne, grasses and other plants which may act as a source of infestation of orchards.

It is stated that "Trithion" used at the rate of 1 lb per 100 gal will give complete control of both eggs and adult mites in one treatment.

"Gusathion" is also said to be effective if applied at 2 lb per 100 gal on a three weekly schedule, or malathion applied at two weekly intervals, using 2 lb W.P. or 1 pint emulsion per 100 gal. Other materials that can be used are "Ovotran", "PCPBS", "Chloroparacide" and "Kelthane".

("Bryobia Mite Control in Orchards." Journal of Agriculture of South Australia, Nov. 1959, 63, (4), 158.)

AUSTRALIA - WESTERN

Potato moth, Gnorimoschema operculella, control: During the last few seasons some growers have reported disappointing results following the use of DDT for the control of potato moth. It was therefore decided to re-evaluate the effectiveness of DDT under local conditions and to test at the same time three newer insecticides. A replicated trial was accordingly planned and laid out at the Wembley Research Station.

Steps were taken to ensure a reasonable moth population. However, this resulted in an unusually heavy infestation and, after an early severe setback, it was considered advisable to re-treat at the first sign of re-infestation. Four applications were made at intervals of nine days. DDT, endrin, dieldrin and "Dipterex" were used at the following rates:-

DDT 20 per cent. emulsion - 2 pints of concentrate per acre

Endrin 20 per cent emulsion - 1 pint of concentrate per acre

Dieldrin 25 per cent emulsion - $1\frac{1}{2}$ pints of concentrate per acre

"Dipterex" - 1 pint of concentrate per acre.

A knapsack sprayer was used and spray was applied at about 50 gal to the acre.

Leaf samples were taken from the plots and the figures obtained from damaged ratings were analysed. These showed that DDT, dieldrin and endrin at the rates used gave good control of potato moth. "Dipterex", whilst giving a measure of protection, was inferior to the other treatments at the rate applied. DDT was the most economical treatment.

A second sampling carried out three weeks after the last application of insecticide failed to show any difference in levels of re-infestation between the treatments although damage had increased in all plots during this period.

At the conclusion of the trial the crop was dug to determine yield from each treatment. All treated plots returned higher yields than the untreated control plots, but DDT, dieldrin and endrin showed significantly higher yields than "Dipterex".

In discussion the authors state that DDT is still able to give satisfactory protection against the potato moth and no supporting evidence for suggested resistance emerged from the trial. Under normal conditions two or possibly three treatments of DDT, thoroughly applied, at the rate of 2 pints of concentrate per acre, should be quite adequate to protect summer crops. Depending on the equipment used and the stage of growth of the crop, the quantities of concentrate quoted above would normally be mixed with a sufficient quantity of water to ensure a good even cover - this could vary from 10 to 100 gallons depending on whether low or high volume plant was used.

(J.A. Button & L.E. Koch. Journal of Agriculture of Western Australia, Nov. - Dec. 1959, 8, (Third series), (6), 653-6.)

Aphid Control: "Black Leaf 40" or nicotine sulphate is still extensively used for the control of aphid, the recommended formula is:

Nicotine sulphate - 1¼ pints (2 teaspoonfuls)
White spraying oil - 1 gallon (3 tablespoonfuls)
Water - 100 gallons (1 gallon)
Soap - 4 pounds (1 ounce) may be used instead of white spraying oil.

When citrus and other hardy trees are requiring treatment the white oil strength may be increased from 1:100 to 1:40. Such a concentration will also prove effective against most scale insects found infesting oranges and lemons.

The use of DDT for aphid control is not to be recommended except under special circumstances as the insecticide kills many useful parasites and may lead to an increase in some scale insects and mites. Where for any reason DDT is desired for aphid control, emulsion types are recommended. Several workers have reported them superior to the wettable powders and the concentration suggested is 0.1%. A combination of insecticides particularly useful to market gardeners is a dust consisting of 2% DDT and 2% BHC. The former satisfactorily controls chewing insects such as cabbage caterpillars and the BHC reduces the aphid population.

Hexone and parathion were both developed during the war to alleviate a world shortage of nicotine sulphate and have proved most effective substitutes for the tobacco extract. It is stated that Hexone, malathion and the systemic insecticide "Metasystox" are probably the most generally useful insecticides against aphids.

("Aphides". C.F.H. Jenkins. Journal of Agriculture of Western Australia, 1960, 1, (1) (Fourth Series), 25-29.)

CANADA *

Cattle Grubs: A large-scale test of the systemic insecticide Trolene, involving about 1,000 head of cattle and designed to test the possibility of eliminating cattle grubs from an isolated area, was begun in British Columbia. In the first season the grub population fell by 76% and gadding caused by the adult fly was markedly reduced. The cost of treatment was estimated at $2,50 per animal. Administration of Trolene appeared to have no adverse effects in animals with coccidiosis or when given simultaneously with inoculations for brucellosis and hemorrhagic septicemia. There were, however, a few reports (fewer than 1 per 1,000 animals treated) of injury and death following damage to the pharynx during administration by bolus with a balling-gun.

A second systemic insecticide was registered, under the name Co-ral. It is applied as a spray and, in tests in Alberta, reduced the number of grubs by about 90% when 1 gallon of 0.75% liquid was applied per animal.

Spruce Budworm: A decline in the incidence of attack in New Brunswick is reported, partly attributed to increased natural control. About 2½ million acres were sprayed by Forest Protection. Twelve Grumman Avengers and 76 Stearman planes were used. Aerial spraying operations using DDT were conducted in Quebec over 794,000 acres of balsam fir forests. In 1958, as in recent years, this pest devastated more of Ontario's timberland than any other forest insect.

Pine Root-collar Weevil: This weevil has recently become a serious pest of Scots and red pines growing in nurseries and plantations. Lindane and dieldrin applied as sprays to the bases of trees and adjacent soil will control the adults. Lindane emulsion, 0.05% gamma, applied June, 1955, to trees 5½ feet in height at the rate of 0.83 pints per tree, reduced populations by 89% in 1955, 95% during 1956, 100% in 1957 and 99% during 1958. Dieldrin emulsion at 0.2% concentration applied June, 1955, at the rate of 0.87 pints per tree, resulted in population reductions of 96% in the fall of 1955, 100% during 1956, 98% in 1957 and 99% during 1958.

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Footnote: *Pesticide designations conform to the recommendations of the Entomological Society of America.

Wheat Rust: Inorganic salts of nickel were tested as eradicants for rust control in field plots at Winnipeg. Both nickel chloride and nickel nitrate, applied at the rate of one pound per acre, gave control of rust and increased yields of grain. For effective control it may be necessary to spray at 7 or 8 day intervals after a trace of rust appears in the crop.

Wheat Midge: The wheat midge was again present in the Red River Valley of Manitoba, where an average of 36% of the heads and 5% of the kernels were infested. Pre-planting applications of Thimet, Di-Syston, and NC262, and sprays of Thimet, demeton, NC262, and lindane applied at heading time, did not control the midge.

Barley Jointworm: In Prince Edward Island, none of various systemic insecticides was effective against the barley jointworm when applied to the soil before planting. Sprays of lindane applied to the crop when the adults appeared gave inadequate control.

European Corn Borer: Various plant parts of sweet corn treated at Harrow against the European corn borer, were analyzed at harvest. While significant amounts of residual pesticide were found on the stalks, leaves and husks, residues in the kernels were below 0.1 p.p.m. for heptachlor granular, below 0.2 p.p.m. for endrin granular and DDT (both spray and granular) 0.59 p.p.m. for Dipterex granular, and below 1 p.p.m. for malathion granular. Residues of heptachlor and DDT are below the tolerances for corn set in Canada for these chemicals and the residue of malathion is below the amount allowed in the United States. No tolerances have been established for the other two chemicals on corn.

Alfalfa Plant Bugs: In a two-year study in northern agricultural areas of Saskatchewan, an application of DDT, heptachlor, or dieldrin, at 1.25, 1, or 0.5 pounds per acre respectively when early-hatching plant bugs were nearly full grown and *Lygus* bugs were beginning to hatch, gave practical control of these pests in alfalfa seed fields. These treatments increased the percentage of viable seeds from 11 in untreated plots to about 90 in the treated plots. Since the application was made before the alfalfa was in bloom, insecticide residues were not a serious hazard to pollinators. In addition, the alfalfa recovered completely from damage caused by the passage of spray equipment.

Beet Webworm: The most severe infestations of the beet webworm in 25 years in the Prairie Provinces caused widespread and severe damage to flax, safflower, rape, mustard, and sunflower crops where chemical control was not used. Aldrin, endrin, and dieldrin gave good to excellent control when applied at recommended rates and before severe defoliation occurred.

Rape Diamondback Moth: Damage to rape by the diamondback moth caused losses of 25 to 50% in widely separated districts of Western Canada. This is the first record of so general and severe an outbreak of this pest in the region. DDT sprays gave satisfactory control.

Potato Wart: Potato wart was almost completely controlled and yields increased by applying Mylone at 400 pounds per acre to heavily infested soil at Bay Roberts, Nfld. At 300 and 150 pounds per acre the disease was less well controlled. Vancide 51, mercurous chloride, and pentachloronitrobenzene also gave some control but were not as effective as Mylone. Increasing the rate of all four materials resulted in progressively higher yields because of improved set of tubers.

Potato Aphids: In New Brunswick, the systemic insecticides Di-Syston and Thimet applied to seed pieces of potato, and granular Di-Syston applied to the soil around the seed pieces at planting time, each gave excellent control of the four common species of aphids on potato throughout the season. Granular Di-Syston had no harmful effect on yield, but the seed-piece treatments reduced emergence and yield significantly. Treatments of the seed with diazinon and NC262 had little effect on yield but did not give satisfactory control of aphids.

Potato: Aphid-borne Viruses: Work in New Brunswick pointed to a new way of controlling a large group of plant viruses spread by aphids. Aphids transmit these viruses simply by probing superficially first into infected and then into healthy plants; they do this within a minute or two, which is somewhat more quickly than present-day insecticides kill aphids. They carry the viruses at the tips of their needlelike mouth parts; and infections in plants usually begin from virus that passes from the mouth parts to the first layer of cells they penetrate. The infections can be stopped in the early stages by various treatments that affect the outermost cells. One such treatment is to spray plants with water containing a minute amount of trichothecin, an antifungal substance. At present it is not possible to kill migrant aphids quickly enough to prevent them from introducing these viruses into our crops; but it should be practical to stop the infections in the early stages. Partly as a result of this work, industrial firms have become interested in pursuing this approach to the control of insect-borne viruses.

Tobacco Brown Root Rot: Cooperative field tests conducted at Delhi, Ontario, in 1958, have shown that chemical treatment of flue-cured tobacco soils for the control of plant parasitic nemotodes which cause the disease known as brown root rot is practical and economically feasible. The application to the soil of 25 gallons per acre of a commercial nematocide (Shell D-D) as a spring pre-plant treatment effectively controlled nematodes and resulted in a significant increase in yield and quality of the tobacco. Chemical analysis of the tobacco leaf showed that no undesirable uptake of chlorine or nitrogen had occurred in plants grown on treated soil.

Tobacco Hornworm: A bacterium lethal to insects, applied in a spray at 225 grams of spores per acre, gave as good control of the tobacco hornworm and the tomato hornworm on tobacco as that obtained with the most effective insecticide, and at 400 grams per acre all the hornworms were dead within 7 days.

Tobacco: Effect of Crop Residues: Experiments are in progress in Ontario to determine under what conditions, if any, decomposition of the residues of some of the crops grown in the area may result in the production of substances toxic to plants.

Cabbage Clubroot and Root Maggot: Several chemicals were tested at Charlottetown in 1958 in seeking a satisfactory method of control for clubroot and root maggot in cabbage transplants. The chemicals were applied as drenches immediately following transplanting into soil known to be contaminated with root maggot and clubroot.

Vancide and mercuric chloride when used alone gave satisfactory control of clubroot. The mercury treatment reduced maggot damage to a slight extent but Vancide had no effect on maggot populations.

The largest number of marketable heads and highest yields were obtained when heptachlor was combined with the mercuric chloride or Vancide. Control of the maggot was almost complete with heptachlor.

Seedling Diseases of Vegetables: Nineteen fungicidal seed-treatment preparations, some of which also contained insecticides, were tested in plots at Ottawa and St.Catharines, Ontario, and at St. Jean, Quebec, for the control of seed-borne and soil-borne organisms that attack vegetable seedlings. Preparations that contained thiram were the best for improving the emergence of peas, beans, corn and cucumber. Captan was also outstanding for peas. Phygon (dichlone) was the best for squash.

Onion Maggot: Aldrin, dieldrin, endrin, and heptachlor did not control the onion maggot in Ontario or British Columbia though each had been satisfactory earlier; many growers lost their entire crops in spite of repeated applications. Elsewhere these insecticides gave excellent control of recommended rates. In British Columbia, diazinon, Trithion, and Guthion seed treatments gave excellent protection against strains resistant to aldrin, dieldrin, endrin and heptachlor. Malathion and dieldrin sprays applied repeatedly against the adults also gave almost complete protection from damage. In Ontario, adults of resistant strains were highly susceptible to diazinon, Korlan, parathion and methyl parathion.

Rutabagas (Cabbage Maggot): In Newfoundland, application of granular aldrin or heptachlor with fertilizer to the soil surface or to a depth of 2 inches gave excellent control of the cabbage maggot in rutabagas. The treatments were ineffective when placed 4 inches deep. In Prince Edward Island, granular heptachlor, aldrin, parathion, and Thimet applied in a 5-inch band and 1½ inches below the seed gave good to excellent reductions in infestations and damage, but Guthion, Ethion, Di-Syston, and malathion did not. Aldrin and heptachlor in surface, drench, and furrow applications also provided satisfactory protection against the maggot in cabbage and cauliflower in tests in each of the Atlantic Provinces.

Seed-Corn Maggot: In southwestern Ontario the seed-corn maggot is an important pest of beans, soybeans, peas, onions and peppers, and occasionally of many other crops, especially during cool, wet springs when seeds germinate slowly. In numerous tests, a seed dressing of 0.4 ounces of dieldrin or heptachlor combined with 1.5 ounces of thiram or captan per 100 pounds of seed gave excellent control. Storage of treated corn, field beans, and soybeans for two years did not adversely affect germination of the seed or control of the maggot, but it reduced germination of peas and lima beans about 20%.

Sugar-Beet Root Maggot: In Manitoba, an insecticide-fertilizer mixture containing 1% heptachlor in ammonium phosphate (11-48-0), applied to the drill row with the seed at 80 pounds per acre, gave 70 to 80% reduction in numbers of the sugar-beet root maggot and increased yield of sugar beets by 1.5 to 2.0 tons per acre.

Fruit Crops

Apple Scab: The effectiveness of four fungicides against scab was compared. They were: Cyprex, dichlone, Thylate and Niacide.

Because of adverse local conditions a 10-spray schedule with these fungicides was supplemented by two applications of an organic mercury spray. The fungicides were equally effective in the control of scab. None caused russeting of the fruit. A mild chlorosis of the leaves was observed in late summer with dichlone, used at full dosage until the end of July.

Powdery Mildew: With the wide use of organic fungicides for control of apple scab, there has been a marked increase in the Niagara Peninsula in the prevalence of powdery mildew in many orchards. To improve control of this disease sulphur was added to the regular spray of an organic fungicide. The addition of 3 pounds of sulphur reduced mildew but control was inadequate. Best control was obtained where sulphur was added at the 6-pound rate. Two experimental fungicides specific for powdery mildew, ranked below sulphur. In the Ontario spray calendar for apples addition of sulphur to the scab fungicide is now recommended.

Storage Rots: Over a four-year period, apples from trees sprayed with an organic mercury fungicide have developed less Gloeosporium and other storage rots than fruit from trees sprayed with captan, glyodin or sulphur. The captan-sprayed fruit were second best. A program of organic mercury fungicides before bloom and captan in the cover sprays is recommended in orchards where this rot is a problem.

Brown Rot of Stone Fruits: In the Kootenays brown rot in ripe cherry fruits has been controlled adequately by a three-spray program as follows: captan two weeks after shuck fall and ferbam plus self-emulsifying oil two weeks later and immediately before picking. Commercial shipments of sprayed cherries reached the market with less than 1% rotted fruits, whereas unsprayed orchards could not be picked.

Modified Spray Programmes: The principle is to limit the use of widely toxic pesticides such as sulphur, dinitro compounds, petroleum oil, the chlorinated hydrocarbons such as DDT, DDD and BHC, and the organo-phosphates such as parathion, malathion and TEPP. Among the materials substituted for the foregoing are the fungicides glyodin, captan and the organo-mercurials; and the insecticides nicotine sulphate, lead arsenate, and ryania. Although most of these are toxic to larger groups than desired, they may be used to control pests without unduly increasing pest populations indirectly by destroying beneficial species. A major result of the programme has been that no destructive outbreaks of plant-feeding mites have occurred, though many of the newer organic pesticides have promoted such outbreaks in other areas.

Apple Aphid: In British Columbia a spray of the experimental insecticide 12880 prevented the apple aphid from reinfesting apple for 30 days; a spray of Guthion or Sevin, for about 20 days. Diazinon and Phosdrin gave no residual protection. Small amounts of 12880 on cloth bands around the trunks of young dwarf trees also gave protection against the aphid for six weeks. In southwestern Quebec, sprays of Guthion, demeton, malathion, Trithion, diazinon, and WC-1 each gave good immediate control. In another experiment, Sevin had considerably more residual action than Phosdrin or malathion.

Fungicides affected the abundance of the apple aphid through their effect on twig growth in southwestern Ontario. Plots receiving complete seasonal programmes of Niacide or captan produced the greatest twig growth and had the greatest number of aphids; plots treated with colloidal sulphur had intermediate values; and those treated with glyodin grew the least and had the fewest aphids.

Strawberry Diseases: Schedules of spraying with captan, maneb, and Cyprex were tested at Ottawa for the control of fruit rot, leaf spot, and leaf scorch of strawberries. All three fungicides gave some control of fruit rot. Maneb reduced leaf spot by about 75% while captan and Cyprex reduced it by about half. Cyprex completely controlled leaf scorch while the other two fungicides were only partially effective.

Fungicides - General: When seed dressings contained both an insecticide and a fungicide, emergence of plants was better than with the use of a single pesticide. It was demonstrated that insecticides can retard the growth of pathogenic fungi cultured in artificial media. Degradation of some of the fungicides is being studied.

A study of resistance of cereals against root rot has led to the isolation from barley of an antifungal chemical. This is being characterized and should aid in the more rapid selection of rot-resistant varieties.

Methyl bromide is a powerful fungicide. Its efficacy is affected by the temperature and humidity of the air or of the grain being fumigated. It is also an effective fumigant for apple maggot but is apt to injure the fruit.

Insecticides - General: Insecticidal organophosphates are nerve poisons in that they interfere with the conduction of nerve impulses by depressing the activity of the enzyme cholinesterase. The insecticide

TEPP had this effect on roaches and, as occurred in mammals, PAM proved to be an antidote capable of reactivating cholinesterase. It was demonstrated that the continued existence of this enzyme was most important for the survival of house flies and of insect eggs.

From electron photomicrographs and associated physiochemical studies it was concluded that a convoluted membrane immediately below the nerve sheath in an insect contains enzymes important in conducting nerve impulses.

Radioactive isotopes have proved useful in a study of the metabolism in plants of the systemic insecticide Phosdrin and of compounds related to it. The incorporation of sulphur resulted in a compound that proved far more toxic to insects than it was to mammals.

Apples intended for export must be free of apple maggot. Ethylene dibromide and ethylene chlorobromide effectively controlled apple maggot at 32°F. Storage life was not reduced but the fumigants imparted a burning taste to the fruit. The effect of higher temperatures is being studied.

An analytical method has been devised for the estimation of residues of methyl bromide and ethylene dibromide on fruit, by which 0.1 p.p.m. may be detected in a 20 gram sample.

Miscellaneous Investigations

Grasshoppers: Laboratory studies showed that the dosages of dieldrin, endrin, aldrin and heptachlor required to kill mature nymphs of the migratory grasshopper were in the ratios 1 : 1.4 : 1.5 : 2. For aldrin, differences in susceptibility of nymphs from representative localities in each of the four western provinces were sufficiently small that the same dosage would be equally effective in all regions.

In field tests against nymphs of the clear-winged grasshopper, diazinon at 4 and 8 ounces per acre caused mortalities of 80 and 100% within a few minutes, but it had little effect after the first day. This insecticide may prove useful where insecticide residues must be avoided, such as on forage crops.

Wireworms: In British Columbia, application in 1953 of heptachlor or aldrin at 4 pounds per acre or of chlordane at 10 pounds eliminated a severe infestation of a European wireworm by 1955 and prevented reinfestation even in 1958. DDT at 12.5 pounds per acre reduced the infestation to 30% of that in untreated plots throughout the first five years. Lindane at 1.5 pounds and ethylene dibromide at 1.5 gallons did not give satisfactory reductions in numbers of the wireworm, and re-infestations built up rapidly after the second year.

Wireworms: Attractant: In Alberta, an alcohol extract of the abdomens of virgin females of the sugar-beet wireworm attracted numerous males from distances up to 50 feet. The extract appeared to be specific since males of other species were not attracted by it. The technique shows promise as a means of detecting infestations of wireworms.

Cutworms: In Ontario, aldrin or dieldrin at 0.66 pounds per acre, heptachlor at 1.5 pounds, or DDT at 2.4 pounds, harrowed into the top inch of soil one week before planting, protected tobacco from damage by the black cutworm. Disking the insecticide into the soil to a depth of 4 to 6 inches gave less satisfactory protection, and drilling the insecticide with fertilizer to depths of 1 to 4 inches gave no protection to the crop. Certain phosphate insecticides gave almost as satisfactory control of the cutworm; these provide an alternative means of control should the cutworms become resistant to insecticides now in use.

(Report of the Minister of Agriculture for Canada for the Year ended March 31, 1959.)

CANADA - ALBERTA

Grasshopper Control: It is reported that the infested area in Southern Alberta covered 3,110,000 acres as compared to 1,700,000 acres in 1957: the migratory grasshopper was the worst pest species. Under the grasshopper policy, aldrin and dieldrin insecticides were distributed from stockpiles strategically located throughout the province. Stockpiling of dieldrin, for example, reduced the spraying costs from 25 cents to about 15 cents per acre. Altogether, 35,500 acres were sprayed.

Sweet Clover Weevil: In most areas infestation continued at a high level; several thousand acres were sprayed with Departmental stocks of chlordane and aldrin. Spraying with heptachlor was, however, recommended because of its shorter residual effect on foliage.

(Annual Report of the Department of Agriculture of the Province of Alberta for the Year 1958.)

CEYLON

Tea

Blister blight, Exobasidium vexans: Experiments were carried out to determine whether the copper fungicides now in use for the control of blister blight could be used at a reduced level by the incorporation of stickers. Three stickers (Shell "Tenac", "AAstickol" and "Jebohecht") were tried out with 3 oz of pure copper oxychloride. There appeared to be no significant difference in protection between 3 oz of pure copper oxychloride and 3 oz of copper oxychloride with sticker.

Mites: Four species of mites are known to attack tea; scarlet mite, Brevipalpus australis Tucker; yellow mite, Hemitarsonemus latus Banks; red spider mite, Oligonychus coffeae Nietn.; and purple mite, Calacarus carinatus Green.

Apart from the application of sulphur and the discarding of three rounds of plucking to avoid taints in the made tea, no acaricide has yet been found toxic to yellow mite. Against the three other mites, two non-tainting acaricides, "Akar" (Chlorobenzilate) and "Karathane", are known to be effective.

A recent trial to test the efficacy of acaricidal dusts and sprays for the control of scarlet mites on tea three years from pruning has shown that while spray applications of "Karathane W.P.", "Aramite W.P.", and "Spersul" (sulphur) are all effective, applications of "Karathane" as a 4% dust and malathion as a spray, are not so satisfactory against scarlet mites. Results of a further trial indicate that at least 4 weekly rounds of 4% "Karathane" dust, at the rate of 30-50 lb per acre, are necessary for the achievement of a fair degree of control of scarlet mite.

(The Tea Research Institute of Ceylon - Anhual Report for the Year 1958.)

Coconut

Oryctes rhinoceros Control: In trials the following chemicals were applied as repellents to the leaf axils of palms: (a) dusts - 2% dieldrin, 6.5% gamma BHC ("Gammexane") and 5% DDT ("Didimac"); (b) liquids - 15% dieldrin miscible oil, dieldrin "Extra" and 25% DDT in naphthalene ("Psylortox 25%"). The dusts were used at three levels, mixed with sand in the following proportions by weight - 1:3, 1:6, and 1:9. The emulsifiable concentrates were diluted in water to similar strengths.

In the case of the dust applications the mixture was placed in the three top-most leaf axils of the palm. The liquid application was done by pouring the diluted chemical on to the "cabbage" of the palm by means of a cigarette tin. The palms in the experimental area were inspected daily by a trained beetle catcher and an assistant. During their inspection, the following data were recorded:-

(1) All incidences of beetle attack where the beetles were actually found.

(2) Number of beetles collected from each palm and their sexes.

(3) All incidences of attack where the beetle had attacked and flown away.

(4) Number of dead beetles found.

The data obtained at different cumulative periods viz., (1) fortnight, (2) one month, (3) 1½ months, (4) 2 months, (5) 2½ months, were analysed statistically. In the case of DDT ("Didimac") the variance ratio was just on the border of significance, and the supporting factor was that the incidence of beetle was consistantly lowered with increase in the dosage levels. "Didimac" was therefore considered an effective treatment. The most effective dosage of "Didimac" was 2 parts of chemical to 1 part of sand dilution. "Gammexane" (BHC) and dieldrin dust showed some consistency in the pattern of repellence, but showed no significance in the analysis of variance. Dieldrin Miscible oil and dieldrin "Extra" did not show much repellence; "Psylortox" (DDT/naphthalene) was non-repellent.

Rhynchophorus ferrugineus Control: A number of palms which were being attacked by larvae of Rhynchophorus ferrugineus were treated on an experimental basis with "Systox" and "Dipterex". About 2,000 c.c. of a 0.5% dilution of "Systox" were injected into the trunk of each palm. Nearly 2 days were required for this quantity to flow in. "Systox" injections are said to be very effective; with "Dipterex" higher doses were required.

(Annual Report of the Coconut Research Institute for 1958. Sessional Paper XXI - 1959.)

INDIA

Coffee Pest Control

Entomology: Studies on the seasonal intensity of incidence of the major pests of coffee like the stem borer, green bug and nematodes on arabica and shot-hole borer on robusta and their control by the use of chlorinated hydrocarbons and organo-phosphorus compounds, including systemics, were continued. Studies on the biological control of certain pests on coffee with their parasites were also extended.

In the stem borer control trials at the two Research Stations and in the Liaison Zones, it was observed that dieldrin and BHC gave satisfactory results more consistently than heptachlor, "Gusathion" and chlordane. Addition of stickers to the chemicals did not prove beneficial. Trials with systemics and other organic insecticides on the control of green bug showed that metasystox, "Folidol" and "Gusathion" effected 100% control of the pest three weeks after application of the chemical. Extended trials on the control of shot-hole borer by organic chemicals such as BHC, heptachlor and dieldrin showed that the incidence was least on plants sprayed with BHC. Systemic chemicals like "Metasystox" and "Ekatin" have not proved so far effective. The soil treatments with and without sulphur to control eelworms did not effect any significant reduction in the population of eelworms. On the other hand, application of V.C.13.Nemacide gave indications of significant reduction in their number. Trials with "Crag" fungicide and "Nemagon" were not conclusive.

Studies on the bionomics and life-history of the hairy caterpillar, leaf eating caterpillar, and the green bug parasite were continued in the laboratory. The nomenclature of as many as four different eelworms affecting coffee was determined.

Mycology: Field trials on spraying of coffee to find out efficient and economic methods of control and to evaluate the efficacy of various proprietary fungicides as compared to the standard Bordeaux mixture in controlling the major diseases of coffee and fundamental work on the life-history and possibilities of control of the common diseases were continued.

Comparative spray trials using various proprietary fungicidal formulations based on copper, mercury, sulphur and others of organic nature for control of leaf disease of coffee have shown that ½% Bordeaux mixture now in common use is as good as and in some cases better than the proprietary formulations tested. Addition of detergents, wetters, spreaders, etc., to Bordeaux mixture has not given any significant and consistent improvement in efficacy of disease control. Trials to determine the optimum time of spraying Bordeaux mixture in North-East Monsoon areas, and the use of chemicals in controlling monsoon leaf shed started previously, were continued. An initial sterilization with Bordeaux mixture of formaldehyde followed by routine drenching of the soil with Bordeaux mixture at fortnightly intervals was found to effect a good control of damping off and collar rot disease. Investigations on possibilities of biological control of this disease using different micro-organisms have been initiated.

Studies on the brown eye spot disease showed that the disease was not selective in respect of the different arabica types and that application of 1% Bordeaux mixture, "Flit 406" (0.4%) and "Dithane" (0.4%) gave fair control of the disease. Application of urea, on the other hand, did not reduce the disease incidence. In the special project to investigate the various nursery and post-nursery diseases affecting coffee, information on the incidence, intensity and periodicity of different types of maladies has been collected. Control of the above by chemicals and phyto-sanitary measures was under way.

(Eleventh Annual Report of the Research Department of the Coffee Board 1957-1958. Research Department Bulletin No.11.)

Tea

Red Spider mite. Oligonychus coffeae Nietner: Two field trials were carried out at Borbhetta with "Aramite", "Akar 338" malathion and malathion + "Ovotran" as a prophylactic measure against red spider mite. The incidence of red spider was, however, negligible and there was no significant difference in the degree of attack between the treatments and check.

A field trial was carried out at Tocklai with "Tetram", formerly known as R 6199, at different concentrations of 10 ppm, 20 ppm and 40 ppm and lime-sulphur at 1 in 40 parts of water. "Tetram" in all concentrations, as well as lime-sulphur gave significant reduction of the red spider population over check, but the former at 10 ppm was found to be inferior to lime-sulphur.

Purple mite, Calacarus carinatus Green: In a trial at Tocklai the following treatments gave significant control of the mite:

"Aramite 15 W" at 1 lb/50 gal water

"Aramite" 20% E.C. at 1 pint/93$\frac{3}{4}$ gal water

"Akar 338" at 1 pint/62$\frac{1}{2}$ gal water

Malathion 50% E.C. at 1 pint/62$\frac{1}{2}$ gal water

Lime-sulphur at 1 pint/5 gal water

Looper caterpillar, Biston supressaria Guen.: In a field trial the following treatements were compared:

"Basudin" 20% E.C. at 1 in 500 parts water

DDT 20% E.C. at 1 in 500 parts water

DDT 50% W.P. 1 lb. + Teepol 4 oz in 40 gal water

Malathion 50% E.C. at 1 in 500 parts water

"Endrex" 20% E.C. at 1 in 1000 parts water

Endrin ("Endrex") gave significantly better results than any other treatment within 48 hours of treatment. Observations taken 96 hours after treatment showed endrin to be significantly superior to all other treatments including check. Though there was a general reduction of looper population in all treatments, a slight increase over check was noted in the plots treated with malathion.

Screening of pesticides

"Tedion V-18" (2, 4, 5, 4 tetrachloro-diphenyl sulphone):

This was found to have ovicidal properties on the eggs of the red spider mite; it would appear that to achieve a kill of 70-80%, a concentration of 1 in 500 parts water is required.

Technique Standardisation: In order to increase the efficiency and precision of the techniques used for evaluation of pesticides, comparative tests were carried out to check whether different techniques have any adverse effect either on the host plants or on the test subjects.

The susceptibility of the insect or the mites and the potency of the insecticide are largely dependent upon factors external to the test subject, such as temperature, humidity, food and the period of maintenance of the test subjects after spraying until assessment. The types of vessel and the substratum in which they are confined after spraying and particularly the conditions in which they are confined, are important.

(a) Leaf-method. This particular method is designated "leaf-method" because, a single tea leaf shoot is taken as a "substratum" on which mites are confined and then sprayed. After spraying, sufficient time is allowed for drying. After the leaves are dry the mites are counted on each sprayed leaf-shoot and then confined in a glass tube open at both ends and stoppered at the lower end with a cork. A hole is bored in the middle of the cork through which the twig is passed. The other end of the tube is covered with muslin held tight with a rubber band. The leaf-shoots with mites confined in tubes are then immersed in test-tubes filled with water to keep the shoots fresh. These in turn are kept on a specially constructed stand for observation. Experiments carried out in the laboratory showed that the mites in tubes can be confined up to a period of ten days without any visible deterioration of the tea shoots. There was apparently no change in micro-climate inside the tube, especially the humidity. There was no accumulation of moisture on the sides of tubes, which usually happens in a closed container. Migration of the mites are nil and the mortality in the control was negligible.

(b) Potted Plant method. In this method instead of taking one single leaf as in the "leaf-method", a potted tea plant is taken and mites are introduced. After spraying the potted plant sufficient time is allowed for drying. After the leaves are dry the individual plant is enclosed in a muslin bag. Experiments carried out showed that mites can be kept confined on the potted plants up to a period of one month without much adverse effect on the host plants or the mites themselves. Migration of the mites is a problem. The problem of checking the migration is under investigation.

(Indian Tea Association, Tocklai Experimental Station, Annual Report, 1958.)

Effect of chemical control on the biological balance in cultivated crops

(a) Control schedule for mustard: In the third year of this experiment the aphid infestation was both late and mild necessitating only two sprayings with the various insecticides during the season. Observations showed that on the basis of the average yield from the different treatments, the relative efficacy of the various insecticides was in the order parathion > gamma BHC > "Pestox" > "Basudin" > dieldrin > nicotine sulphate.

(b) Effect of DDT sprays on the balance of pest population in cotton: The experiment was repeated for the second year and sprayings with DDT suspension at the rate of 1 lb per acre were done as last year. Observations after the 5th spraying showed that the population of jassids, thrips, white-flies and aphids was reduced by 100%, 96.2%, 92.6% and 70.8% respectively whereas that of pink bollworm and mite increased by 66.6% and 40.75% respectively.

Studies on insect cuticle in relation to susceptibility of insecticides: The relative solubility of DDT, BHC, dieldrin and endrin crystal suspensions in the films of cuticular wax of *Tribolium castaneum* was studied and this was found to be positively correlated with the relative toxicity of these insecticides to this pest.

Stored produce: Field and laboratory tests were carried out with pyrethrum against important crop and stored grain pests; 0.125% and 0.25% pyrethrin emulsions with kerosene oil or petroleum ether as bases with or without 1% pine oil or 1% and 2% piperonyl butoxide as synergists were sprayed against grubs of *Trogoderma*. The experiments were conducted at laboratory temperature and at controlled temperatures of 25°C, 30°C and 37°C. Pyrethrin emulsions with piperonyl butoxide were found to be more toxic than pyrethrin alone while there was no significant increase in mortality in the case of pyrethrin in combination with pine oil.

(Scientific Reports of the Indian Agricultural Research Institute for the Year ending 30th June, 1957, p.79, 80)

INDIA - MADRAS

Public Health fish farming: Various species of fish continue to be distributed for the control of mosquito larvae. Experiments on the biological control of guinea worm disease have shown that certain fishes such as *Chela cluepeiodes* have possibilities in controlling *Cyclops*.

(Administration Report of the Department of Fisheries, for the Year 1957-58, p.88.)

MALAYA

Oil Palm: It is reported that an experiment on the control of *Curvularia* seedling blight of oil palms, carried out on a co-operative basis, on an estate in Johore, has been completed. Four fungicides, based respectively on TMTD, captan, zineb and copper oxychloride, were compared. Captan gave the best results, treatment with this fungicide resulting in good control of the disease and in improved growth of the seedlings, as judged by the length of the longest frond.

A severe and widespread attack by *Marasmius palmivorus*, which causes rotting of the fruit bunches, occurred on an estate in Selangor. Control is being obtained by severe pruning of affected trees and burning of diseased parts, together with treatment by a copper fungicide.

Coconut: A trap breeding experiment was carried out in an estate in Selangor, the object being to observe whether insecticide-treated breeding pits would prove more attractive breeding sites for *Oryctes rhinoceros* than would rotting rubber. The results of this experiment showed that the pits were quite attractive to the beetles as breeding sites but the insecticide applied (BHC) had little effect in killing the grubs. The experiment is being repeated in the same locality and other insecticides are being tried.

Pineapple: During the year two experiments were conducted on the control of mealy bugs. The object of the first experiment was to discover whether mealy bug wilt could be eliminated by fumigating the planting material from both healthy and wilted plants to rid it of mealy bugs and then spraying the soil with dieldrin to prevent entry of ants and mealy bugs into the experimental area. The experiment was unsuccessful and mealy bug wilt occurred on many plants. The second experiment, to determine whether mealy bug wilt was caused by the feeding and saliva of mealy bugs or by a virus transmitted by the mealy bugs, is not yet concluded.

Cacao:

(a) Helopeltis Control: An experiment was carried out at the Federal Experiment Station, Serdang, on the use of DDT fogging, DDT spraying and "Gammalin 20" spraying. Rates were 10 fl.oz a.i./acre, 2 fl.oz a.i./acre and 2 fl.oz a.i./acre, respectively. Four applications of each insectide were given at fortnightly intervals followed by a fifth application four weeks after the fourth.

Results showed that there was a definite reduction of attack immediately after the first application of the insecticide. This reduction was noted in all treatments and also in the control plot. Even though large plots, of about an acre, are used in these experiments, a reduction in the control plots is almost always noted. The pest began to appear again four to five months after treatment.

In a second experiment also at the Federal Experiment Station, Serdang, two foggings with DDT, "Gammalin 20" and "Aldrex 2" were given at an interval of three weeks. After the first application of insecticide there was a gradual drop in infestation in "Gammalin" and "Aldrex" treated plots but the DDT treated plot showed a very much slower drop. About five weeks after the second application of insecticides, the infestation showed an upward trend. The results of these experiments indicate that more than two applications of insecticide at fairly close intervals are needed if the pest is to be eliminated or reduced to a minimum.

In a similar type of experiment at Kampong Awak, Pahang, "Aldrex 2", "Dieldrex 15" and "Gammalin 20" were applied by spraying at four fl.oz a.i./acre and also "Gammalin 20" at two fl.oz a.i./acre. Two applications, a fortnight apart, were given. Results showed that the attack was reduced to a minimum and remained so for eight weeks, after which the experiment was discontinued.

In another experiment in the same area, "Endrex" was substituted for "Gammalin 20" and again the attack was reduced to a minimum and remained so for about four months after the first application of the insecticides.

(b) Die-back: Investigations, which were undertaken to determine if a viral pathogen was responsible for die-back, were brought to an end. In a series of experiments, evidence was obtained to discount the theory that a mealy-bug-transmitted virus was responsible for the disease.

Tea: An experiment to control Helopeltis on tea at Cameron Highlands by fogging with DDT was concluded during the second quarter of 1958. Fogging was carried out on the day after plucking. Results showed that fogging with DDT did not eliminate the pest and it appears that dusting might be more effective than fogging.

(Annual Report of the Department of Agriculture for the Year 1958.)

Rice: The final experiment was completed in a series of pot trials to compare the effectiveness of several insecticides in controlling stem borers. Of the insecticides tried (DDT, BHC, "Endrex", malathion, "Basudin" and "Rogor 40") all at the rate of 1 lb active ingredient per acre, it was confirmed that "Endrex" was the most effective in controlling the pest and producing the highest yield. The next best was found to be "Dieldrex". Unfortunately neither of these insecticides can be used in the field due to their high toxicities to fish and animals. "Dipterex" was used for the first time in the following experiments.

(a) to compare the effectiveness of "Dipterex" and "Ekatox" in controlling stem borers. "Dipterex" was the more effective but results are not conclusive.

(b) to compare the effectiveness of "Dipterex" at 0.07% and 0.05% active ingredient. Results of the experiment show that the percentage of dead stem borers in both tests are about the same.

It was observed during this second trial with "Dipterex" that the stem borers in different larval instars reacted differently to the insecticides and in a further experiment it was shown that the younger stem borers (half grown and small) are more susceptible to "Dipterex" treatment.

Oil Palm: On one estate, aerial spraying with "Endrex" against bagworms, *Crematopsyche pendula*, was found to be very effective.

("Notes on Current Investigations and Extension Work, July to September, 1959." Malayan Agricultural Journal, 1959, 42 (3), 161-171.)

NEW ZEALAND

Mealy Bug Control in Orchards

Of the *Pseudococcus* genus of mealy bugs in New Zealand, three species, *P. maritimus*, *P. comstocki* and *P. gahani* are reported as attacking pears, while these and *P. adonidum* attack apples. Of these, the grape mealy bug *P. maritimus* appears to be by far the most prevalent and the following notes apply to it.

Recent experiments carried out in Hawke's Bay orchards show that with the large range of insecticides available only the organophosphate materials are effective. In particular two materials, parathion and diazinon, have given good control. However, fairly high rates of application at frequent intervals and with good coverage are essential. Of the two, parathion appears a little more effective than diazinon, but is extremely dangerous to operators, who must wear the recommended protective clothing. Diazinon is safer to the operator, but is more expensive (almost double the price of parathion when used at a strength to give equal control).

Insecticidal Control Recommendations: From first or second week in November and at three-weekly intervals until 14 days before harvesting apply:

	Per 100 gallons
Parathion (31%)	15 oz
or	
Parathion (25%)	18½oz
or	
Diazinon (20%)	1 pint

Ensure best possible coverage to reach bugs in sheltered places on the tree and include a wetting agent in the spray. An autumn application as soon as possible after harvest will reduce carry-over to the next season. (The above strengths could be reduced with closer-interval spraying.)

("Mealy Bug Resurgence in Hawke's Bay Orchards." New Zealand Journal of Agriculture, November, 1959, 99, (5), 481-7.)

NEWS ITEMS FROM THE COLONIAL TERRITORIES

BECHUANALAND PROTECTORATE

Tsetse Control: The Central Policy Committee has recognised that Bechuanaland, like most countries where Glossina morsitans is found, had two problems, viz. that of halting advances and of reclaiming tsetse-ridden country. It was agreed that control measures should differ accordingly. Insecticidal attacks and game destruction were better against advances while discriminative clearing and settlement were preferable for permanent reclamation.

Six de-flying chambers are to be erected at selected points in an attempt to improve the cattle trypanosomiasis position and to assist in slowing down the tsetse advance: a total of 390 tsetse were caught, for example, at two pickets in the Shorobe area from October to December. Other tsetse control measures employed are discriminative hand-felling and ring-barking.

(Report for the Year 1958. H.M.S.O. 1959).

CAMEROONS

Onchocerciasis: A control unit is maintained by the Cameroons Development Corporation to control the breeding of Simulium damnosum. As yet no really satisfactory method to keep a concentration of insecticide in the fast flowing streams has been devised.

Loiasis: The main energies of the Helminthiasis Research Unit which is established at Kumba have continued to be directed towards the investigation of loiasis. A full and detailed study of the epidemiology of this disease has been made over the past years with special emphasis on the complex inter-relationships of the definitive host, the vector and the parasite; the unravelling of these complexities has been regarded as an essential pre-requisite for the successful control of this and other insect-borne diseases. Work continued on these lines, but knowledge has now reached a point where it is thought justifiable on scientific grounds to initiate pilot schemes to control the vector Chrysops and to attempt by other means to prevent the transmission of the disease.

(Report by Her Majesty's Government in the United Kingdom of Great Britain and Northern Ireland to the General Assembly of the United Nations for the Year 1958. H.M.S.O. 1959).

EAST AFRICA

Tea: Weevil larvae caused severe damage to the roots of tea seedlings in tea nurseries on several Sotik estates. Although the adult weevils do little damage, control is aimed at them since the larvae are more resistant than adults to insecticides. The usual recommendation is to bait with a mixture of 1 oz of a BHC preparation (e.g. "Agrocide 7") to 3 lb of chopped green maize or grass. Weevil species found in the nursery were: *Nematocerus striolatus*, *N. perditor* and *Aperimatus brunneus*.

(Tea Research Institute of East Africa Annual Report for the Year, 1958).

HONG KONG

Fly Control: Diazinon was used for the control of flies, principally *Musca domestica vicina* Macq., at the Colony's refuse dump at Gin Drinkers Bay. The dosage rate aimed at was 100 mg per sq. ft., using a 40% wettable powder at 4 oz per Imperial gallon: application was made weekly or at longer intervals depending on the degree of infestation.

Domestic Insect Pest Control: Insecticide formulations in use, and the species against which these were applied, included: 1% diazinon water dispersion and pyrethrins + piperonyl butoxide/kerosene solution against flies (principally *M. domestica vicina*); 1% dieldrin emulsion against biting midges (*Lasiohelea stimulans*); 1% dieldrin/kerosene solution against cockroaches (*Periplaneta americana*, *P. australasiae*, and *Blattella germanica*) and ants; gamma-BHC smoke against cockroaches (*P. americana*) in drains; 1% malathion/kerosene solution against fleas (*Ctenocephalides felis*); 0.39% gamma-BHC/kerosene solution against bed-bugs (*Cimex hemipterus*); and pyrethrins + piperonyl butoxide + dieldrin/kerosene solution against wasps (*Vespidae*).

(Report of Pest Control in Hong Kong for the Year 1958-59. Reprinted from Hong Kong Annual Departmental Report by the Chairman, Urban Council, and Director of Urban Services for the Financial Year 1958-59).

JAMAICA

Banana Leaf Spot

Oil Spraying Experiments: Previously, low volume mechanical mist spraying with oil showed promise of proving a boon to banana growers in Jamaica in their efforts to control leaf spot. This was due largely to the ease with which the new fungicide could be applied in place of the laborious high volume Bordeaux spraying and because it could be used in areas too short of water for high volume spraying. The spray oil also has a remarkable fungistatic effect on the growth of *Mycosphaerella musicola* in the banana leaf after infection has occured, so that plants, heavily infected up to the time of shooting, can have their fruit saved by oil under conditions where Bordeaux spraying can only fail. Oil has, in fact, saved many thousands of bunches of bananas in this way in Jamaica.

Unfortunately time and experience have shown that although these highly desirable features of oil spraying are of great value, other undesirable features have gradually become more noticeable during the period under review. Unless these can be eliminated, the time has now come when a grower has to decide whether the advantages of oil commercially outweigh the disadvantages.

Unlike the conditions prevailing in the French Antilles where the beneficial effect of oil has been measured simply against the ill effects of no spraying, in Jamaica the oil spraying has also to be compared with the well established and successful high volume spraying with Bordeaux mixture. Many growers accustomed to spraying with Bordeaux disliked oil spraying from the start because of the less attractive colour of the oil-sprayed foliage in some localities. As Bordeaux spraying is, however, expensive for the small grower, oil spraying was encouraged in Jamaica after initial trials had clearly demonstrated an equal effectiveness in controlling leaf spot as that originally obtained in the French Antilles. The main difference between the two areas has been the greater phytotoxicity in the Jamaican banana plantations where light brown flecking of the leaf blades becomes increasingly noticeable as the leaves receive repeated applications of spray oil. There appeared to be remarkably little adverse effect of oil on the grade and weight of fruit produced in oil-sprayed fields considering how, under the microscope, so much damage is seen to be done to stomata and tissue adjacent to vascular bundles.

In the 1956/7 Report, an apparently new trouble associated with oil spraying was recorded, namely, sheath splitting. The first case of this occurred where sudden growth followed after the end of a long spell of drought. Sheath splitting, however, became increasingly prevalent towards the end of the wet season in 1958 when the full significance of it was first appreciated. This trouble does not occur either on Bordeaux sprayed or on unsprayed bananas. There is every indication that the Lacatan banana is much more susceptible to sheath splitting than the Robusta, although both show the effect of phytotoxicity in the foliage. An experiment, described later, comparing three new spray oils has tended to confirm this view because in the two Robusta blocks at Bog Walk no cases of sheath splitting were recorded, whereas there were several cases noted among Lacatan plants in St. Mary. In this connection it should be noted that Robusta is the main variety both in the French Antilles and in the Windward Islands where phytotoxicity of oil is not considered serious, although, in the Windward Islands sheath splitting has been seen.

Originally, in Guadeloupe oil was applied at the rate of $2\frac{1}{2}$ gallons per acre and phytotoxicity was apparently negligible, yet, in some parts of Jamaica, when only 1 to $1\frac{1}{2}$ gallons of oil are applied at 3-weekly intervals, phytotoxicity is conspicuous even during the wet seasons. Unfortunately during the height of the infectious season for leaf spot the cycles have to be shortened to 2 weeks where the disease is inclined to be severe, especially nearby to unsprayed bananas. Phytotoxicity is definitely worse on some Jamaican soils than on others being especially noticeable wherever banana plants are subject to the slightest drought. It is not severe in well irrigated plantations. The greater incidence of sheath splitting in ratoon plants suggests that the adverse effect of oil is cumulative.

The small amount of noticeable phytotoxicity in the islands mentioned above would seem to be due to the greater depth of their free-draining volcanic soils in which the bananas develop a deep root system, better capable of withstanding short dry periods than on the heavier Jamaican soils. Not until sheath splitting became widespread did the Research Department seriously question the advisability of oil spraying and initiate experiments to evaluate phytotoxicity by direct comparison with water-miscible sprays.

Although oil spraying meets with disfavour in many parts of Jamaica, there are still several growers who prefer it and are anxious to continue with its use. One of the biggest problems facing the Research

Department is that of assessing the effect of oil on the shipping qualities of the fruit. There is, for instance, a possibility that the property of the oil which weakens leaf bases, sufficiently to cause sheath splitting, may also be capable of weakening the tissues of the finger stalks. This might make them more susceptible to the type of damage in handling which later results in the development of Santa Marta stem end rot.

New Spray Oil Trials: The undesirable feature of phytotoxicity prompted the Research Department to request the Oil Companies, in Jamaica, to produce less toxic spray oils, without impairing their fungicidal properties. The Department has insufficient staff to undertake extensive oil trials, so the policy adopted, in co-operation with the Oil Companies, has been for the Companies to do their own screening trials and when improved marketable oils are discovered, the Research Department carries out field trials, with the new product, Two such trials have been undertaken during the period under review.

In one trial four new spray oils screened by one Oil Company were compared. The result of this trial showed that all the oils gave good and practically similar control of leaf spot, but the phytotoxicity of two oils was significantly less than that of one oil claimed by the Oil Company to be very similar to that used originally in Jamaica. The slight improvement in the two oils regarding phytotoxicity was considered sufficient to warrant a changeover to one of these oils, if the price was reasonable, even though they had not shown the amount of improvement really desired. Difficulty arose in choosing between the two oils and this was done by referring to notes made throughout the trials; as a result, one oil was chosen. In the other trial comparative trials were made between new spray oils marketed by three different Oil Companies. The results showed no difference in the effect of these three new products either in regard to leaf spot control or in phytotoxicity, leaf spot control being in all cases of a high standard.

Copper Fungicides Trial: In view of the adversity experienced with oil spraying in many important banana growing areas, a trial was planned to test the effect of copper oxychloride from two sources, cuprous oxide and Bordeaux mixture, all applied in low volume by the mechanical mist spraying machines used in oil spraying. Treatments were applied, fortnightly, down every row. This is essential for success with low volume mist spraying, using non-eradicant fungicides, in order to provide the best chance for the spray reaching the under surface of the youngest leaves. In young bananas the spraying should be adjusted to the height of the plants because this type of spray, simply drifting on to the upper surface of the leaves, cannot control ascospore infection. Unfortunately the copper oxychloride was applied at double the recommended strength but the trials showed conclusively that this type of spraying can keep bananas under a high standard of leaf spot control, especially if they are not closely adjacent to a source of heavy infection.

The trials showed that provided a field of bananas is brought under a high standard of control, prior to the wet season - August to October - even the tallest Lacatan bananas can be maintained at that standard using only 4 gallons of a spray mixture per acre.

Banana Borer Weevil, Cosmopolites sordidus

Investigations into the control of banana borer started in June 1956 and were continued until the end of 1958. An unsuccessful attempt to introduce the predaceous beetle, Plaesius javanus, into two banana plantations was followed by experiments in the use of insecticides. Dieldrin has effected a high degree of borer control over a remarkably long period of time following one application to the soil. The borer population in banana plantations was found to be somewhat lower than expected when a survey was made in 1957-58.

A preliminary trial was carried out comparing three insecticides with untreated plants in four, $\frac{1}{2}$ acre plots. Dieldrin applied in water onto the ground close around the base of banana mats achieved a much higher standard of control than either BHC gamma isomer or "Cosmopolicide 109".

Banana Blackhead Toppling Disease

Blackhead disease of bananas was first discovered and described in Jamaica over 40 years ago by Ashby when Gros Michel bananas were apparently affected only in a few districts. It was caused by the nematode, Tylenchus similis Cobb., now called Radopholus similis Cobb., the "burrowing nematode."

In a preliminary trial the following treatments were made:

(a) immersion of heads in solutions or emulsions of nematocides in water just prior to planting

and (b) placement of a solid nematocide in the planting hole.

In this experiment, in which the whole root system of each plant was examined, "Nemagon" and parathion effected a high degree of control although the "Nemagon" Emulsifiable Concentrate (N.E.C.) was toxic at the higher concentrations. "Vapam" was ineffective as used in this trial in which it was also non-phytotoxic. As a result of this trial, further experiments were designed to use "Nemagon" in both liquid and solid form, it being much more safely handled than parathion.

A large scale randomised experiment was started in July, 1958, to compare the effect of "Nemagon" added as granules and as N.E.C. at planting time on irrigated land. The granules, in this experiment, were applied mixed with gypsum as a filler and were dusted around the base of the banana heads after they had been placed in the planting hole, similarly N.E.C. was sprayed on to the base of the heads. The only results obtained by the end of the year showed that the "Nemagon" E.C. was slightly phytotoxic used in this way but the granules were not.

(Banana Board Research Department. Annual Report 1957-58.)

KENYA

Bilharziasis: It is reported that the method of controlling bilharzia in the irrigation schemes has been altered from one of constant treatment with copper sulphate to a system of surveillance of the human population. The canal waters will be treated with sodium pentachlorophenate in the event of human infection. The original method of control was proving very expensive and there was no evidence to show that is was necessary.

Work done by the Division of Insect-borne Diseases has shown that baboons can be naturally infected with bilharzia. It is not yet known if this infection can occur in the absence of the human host but there is presumptive evidence that this is so.

(Colonial Office Report on the Colony and Protectorate of Kenya for the Year 1958. H.M.S.O., 1959).

Coffee - Weevil Damage: Young coffee plants, especially those which have been planted out for less than a year, are often attacked by the weevil Systates. This is a black beetle nearly half an inch long with a rather swollen abdomen. During the day it hides in the mulch or loose soil near the plant. It is not able to fly. At night it climbs the plant and feeds on the edges of the leaves. The areas eaten may be a simple U-shape, or like little rounded fjords cut in more than half-way to the mid-rib. In severe attacks most of the leaf area is lost and the growth of the seedling is checked.

Affected plants should be treated with DDT. Three pints of emulsifiable concentrate in 100 gallons of water is a suitable strength for spraying. Alternatively, a 5% DDT dust may be used. Lead arsenate, being a stomach poison, is also effective at the usual rate of 1 lb in 40 gallons of water.

(Kenya Coffee, Dec. 1959, 24, (288), 485.)

Coffee Berry Disease: "For control of coffee berry disease, copper formulations, at high concentration, applied at high volume (not less than 180 gallons per acre) over certain clearly defined periods are recommended. Copper thus replaces previous recommendations involving the use of captan. Although, as can be seen in the results of certain field experiments, captan does exercise a partial control of coffee berry disease (even in areas subject to severe attack), control is not consistent. Copper, however, will give consistent control and potential yields may be approximated."

The fungicides used in the various areas are either 50% copper formulations at 14 lb/200 gal/acre or proprietary Bordeaux mixture formulations at 40 lb/200 gal/acre.

("Notes on the Control of Coffee Berry Disease. "K.R. Bock, Kenya, Coffee, Jan. 1960. 25, (289), 16-17).

MAURITIUS

Medical and Health Department

Malaria: There was a visit during the year by a W.H.O. Malaria Advisory Team. The recommendations were that the routine residual spraying should be discontinued and more emphasis placed on surveillance and treatment.

Rodent Control: Rodents are mostly destroyed by poison (Warfarin and zinc phosphide). This means that infestations are cleared without any traces of rodents, alive or dead, being seen. Trapping is also carried out.

Insect borne Diseases Division

Mosquito behaviour: Results of an investigation to discover the natural diurnal resting places of the mosquitoes of Mauritius indicate that low, thick bushes, among which *Lantana camara*, which is locally known under the name of "vieille fille", is perhaps the commonest and can be classified as the most favoured driunal resting places of the mosquitoes so far collected. As for *A. gambiae* and *A. coustani* in particular, apart from bushes, as just defined, both "rough stone walls and rock crevices " and "cowsheds" act as excellent resting places especially for fed individuals. However, it seems that "stone walls and rock crevices" are somewaht more important in the case of *A. coustani.*

The preference of *A. gambiae* and *A. coustani* for cowsheds as resting places depends, to a large extent upon whether or not the cowsheds have been sprayed with wettable DDT. It was observed that unsprayed cowsheds or cowsheds in which the effect of DDT had faded out considerably are more readily chosen by these mosquitoes for resting during the day rather than those cowsheds in which the DDT treatment has still some deleterious effect on their behaviour.

The resting behaviour of *A. gambiae* in "stone walls and rock crevices" and in "bushes" was more particularly studied. It was observed that before dawn, *A. gambiae* adults (males and females) will rest near the edges of the openings of the stone crevices, particularly in rough stone walls of about 3-4 ft wide, and that later on, i.e. after sunrise, when both the temperature and the light rise and the relative humidity falls, this species will move gradually inside the crevices. At about noon, on a sunny calm day, *A. gambiae* adults have moved further inside the crevices, up to 15-18 in. deep, where they find the desired conditions of temperature, light and humidity for resting.

Further study on the diurnal resting places of Mauritian mosquitoes, especially *A. gambiae* and *A. coustani* will be carried out.

Feeding habits: It appears that *A. gambiae*, *A. coustani*, *A. maculipalpis* and *C. tritaeniorhynchus* collected in their natural diurnal resting places, feed more readily upon cattle than upon any of the other animals (including man) of which antisera were available. *Culex fatigans* feeds mostly on poultry and other birds.

Predators of mosquito larvae: The newly-introduced fresh-water fish, *Tilapia melanopleura* was noticed to feed greedily on larvae of

Anopheles gambiae and *Culex* spp. As this fish had been, and is still being, distributed in rivers, ponds, basins, etc., throughout the island, it is expected that it will help in the control of mosquito larvae.

(Annual Report, 1958.)

Fruit Flies: Work on the control of fruit flies with insecticides is in progress: "Dipterex", malathion, sodium silicofluoride and DDT are at present recommended against these pests, the first three especially in bait sprays. When using "Dipterex" (wettable powder) at the rate of 0.2% active ingredient in sprays and 0.6% in bait sprays, infestation dropped from 80% to 10% after 4 treatments at weekly intervals.

Malathion and sodium silicofluoride are most useful against *Ceratitis rosa*. In once locality the percentage attack on peaches dropped to 40%, as compared to 100% in untreated neighbouring orchards, after weekly bait sprays with sodium silicofluoride. DDT is used on a large scale in Reunion with some success at the rate of 0.6-0.7% active ingredient.

Mango: Trials with chlordane and "Dipterex" against the cecidomyiid fly on mango, *Procontarinia matteina* Keiffer and Cecconi, were carried out. Monthly sprayings with 0.5% chlordane and 0.2% "Dipterex" with "Agral" at the rate of 5 c.c. in 10 litres gave almost complete protection of young plants. Other experiments to control the mango gall midge are in progress and work on its parasites has just started.

Egg Plant: A combined weekly treatment of the systemic insecticide "Rogor" and "P.P.Ovicide" proved effective in controlling "*Tetranychus marianae* Mc.G on *Solanum melongena* L.

Tobacco

(a) Ant Control: The use of aldrin and chlordane in controlling red ants on seedbeds was studied. Aldrin 40% W.P. at 5 grams per square foot was applied:

(i) as a drench in 14 gallons of water; and
(ii) as powder mixed dry with the top few inches of soil.

Chlordane was applied likewise at the rate of 2.5 grams per 100 square feet.

All the treatments gave adequate control against red ants and cutworms. The beds where the chemicals were mixed with the soil gave better results than the drenches, but there was no apparent difference between aldrin and chlordane.

(b) Leaf Eating Caterpillars: Aldrin and endrin sprays were tried without success against these pests. A mixed spray of lead arsenate and DDT, however, proved effective.

(Annual Report of the Department of Agriculture for the Year 1958).

Tobacco: (general) Experiments on the control of pests and diseases were continued at Richelieu and Pamplemousses Stations. "Nematox" (ethylene dibromide - E.D.B.) has given good control of eelworms. "Vapam" (sodium methyl dithiocarbamate) has controlled eelworms and most weeds. Methyl bromide has proved to be the most efficient soil sterilant, but is a highly dangerous gas and, at present, cannot be recommended to growers. "Vapam" should be popular with growers because it is easy to apply (1 quart mixed with water to make up 2 gallons is watered over 100 sq.ft of bed) and will control eelworms and most weeds in seedbeds. Zineb (zinc ethylene bisdithiocarbamate) has given very good control of damping off and leaf spot diseases and is recommended in place of Cheshunt compound plus "Soltosan" (copper oxychloride). Aldrin or dieldrin gives excellent control of soil insect pests, such as seed-carrying red ants and cut-worms. Trials have also been carried out on the control of powdery mildew with "Karathane" (dinitrocaprylphenylcrotonate.)

(Annual Report of the Tobacco Board for the Year ended 30th June 1959.)

NIGERIA - WESTERN REGION

Forest Pests: Trial spraying against attack by ambrosia beetles of thinnings of Nauclea diderrichii (Opepe), extracted for telegraph poles from Akilla Plantations, was carried out. The most effective spray appears to be a 5% solution of BHC in oil.

The forest Officer at Benin reports the destruction of Pentaclethra seed by rats when sown at stake in Ogba Fuel Plantation, Benin. Trials amongst other species elsewhere have shown that pre-germinated seed is not attached and the method will be given a trial at Ogba.

There was no repetition of the heavy capsid attack on natural seedlings of Triplochiton scleroxylon in Ilara Reserve which occured in 1955-56.

The presence of serious grub damage in mature *Khaya grandifoliola* has been reported in previous years from Ife, Shasha and Owo Reserves. Many logs have been declared unmerchantable from this cause but it is hoped that attack is not general. Present indications are that attacked trees are confined to pockets. The presence of extensive pinworm damage in mature stems of *Terminalia superba*, particularly prevalent in this species in Omo Reserve has led to the rejection of this species for railway sleepers and wagon bodies. As this attack occurs during the life of the growing tree, no obvious solution to the problem offers itself.

(Annual Report on the Forest Administration of the Western Region of Nigeria for the Year 1957-58.)

NORTH BORNEO

Malaria: The malaria control project sponsored jointly by the Government, W.H.O. and U.N.I.C.E.F. which began in mid-1955 continued. By the end of 1958 the island of Labuan and the Interior Residency had been sprayed three times with insecticide; and in many of the districts concerned, doses of anti-malarial drugs were administered to the public at the same time as spraying. No new indigenous case of malaria was reported from the island of Labuan throughout the year and it is now anticipated that the control methods found to be satisfactory can be extended to cover the entire Colony by the end of 1960. As an example of the present scope of the work, during the second half of 1958 over 11,000 houses were sprayed and, in consequence, a population of more than 54,000 persons protected.

(Annual Report 1958. H.M.S.O., 1959.)

RHODESIA

Whitegrub Eulepida mashona Control: In an experiment in the control of whitegrubs in a ley pasture, insecticidal treatments included dieldrin, applied at the rate of 1, 2 and 4 lb of actual insecticide per acre DDT at 2, 4, and 8 lb of actual insecticide per acre and untreated controls, of which there were two in each block. The insecticides were mixed with kaolin to give a total weight of 4 lb of dust applied to each treatment at the various rates of insecticide application and were applied by hand on 26th November, 1957. The insecticide was incorporated into the surface layers of the soil by light discing. Counts of larvae (whitegrubs) in each treatment were made at intervals during the following season.

Dieldrin, applied at 1 lb of actual insecticide per acre, gave almost complete protection from whitegrubs and it is possible that a lower rate of application would be effective; further experimentation would be necessary to decide this point. DDT at the various levels was significantly less effective than dieldrin in reducing numbers of larvae with the exception that DDT, at 2 lb of actual insecticide per acre was not significantly less effective than dieldrin at 1 lb of actual insecticide per acre. It should be noted, however, that DDT at the higher rates of application apparently gave less effective control than at the lowest rate of application but the assessment of the growth of the sward did not show these differences.

From the practical point of view it would seem that, in areas where a moderate to high incidence of whitegrub infestation can be expected, land should be treated with an insecticide before seeding to a ley pasture.

("The Biology and Control of Whitegrubs, Eulepida mashona Arrow, in Ley Pastures." C.E. Taylor and C.N. Smithers. Rhod.agric. J., 1959, 56, (6), 240-2.)

SIERRA LEONE

Malaria Control: We are in receipt of a note from Mr. R. Elliott to qualify the information given in a previous news item (PANS, 5, (4), 466-7). During a survey of Freetown carried out by this entomologist in 1957 positive evidence of a BHC resistance (Western Sokoto type) was determined. The result has been to replace BHC for residual treatments with DDT. Larviciding operations are continued as before.

Further particulars are contained in the report: "Survey of Freetown" (with appendix on "Presence of Dieldrin and BHC Resistance in A. gambiae in Freetown"), by R. Elliott, Entomologist, Malaria Service, Yaba, Lagos.)

TANGANYIKA

Beans: In trials, seed dressing with aldrin 40% wettable powder at the rate of 1 lb powder per 100 lb seed has given a measure of control against the bean-fly, Melanoagromyza phaseoli.

Cashew: Work has continued on Helopeltis. The blanket dusting of an area of young trees begun in 1957 was continued using 0.5% BHC dust. Helopeltis attack did not develop during 1958 but it was found that the set-back to the undusted trees continued into 1958, dusted trees being approximately 7 feet high whereas the controls were 5 feet 8 inches high. The trees came into flower for the first time in 1958 and it was found that in this respect also the treated trees were superior to the control. A higher percentage of treated trees, 79 as against 44, bore inflorescences and also bore twice as many inflorescences as the control, 9 as against 4.

Papaw: Greenhouse experiments using various organic fungicides as soil drenches showed that zineb gave excellent control of damping off without phytotoxic effects.

Pyrethrum: Die-back resulting in reduced stands has been investigated at West Kilimanjaro and Oldeani. The cause of reduced stands seems to be complex, partly due to fungi and partly to insects. Also, primary insect attack may provide a means of entry for fungi. A species of *Pythium* has been isolated frequently from the stems of rotting plants. Planting on ridges to avoid water-logging has been recommended to prevent such rotting. A prophylactic treatment of the setts before planting out by dipping in a 50% copper fungicide (5 lb per 100 gal of water) has been recommended to protect roots damaged during transplanting.

On Meru the main insect pests are soil insects a cetoniid (*Microlaphinus adsperula*), an unidentified melolonthid and a tipulid. Leaves and flowers are damaged by onion thrips (*Thrips tabaci*) and red spider mite (*Tetranychus telarius*). The application of dusts of 1.25% and 2.5% aldrin and 1% gamma BHC in planting holes resulted in a satisfactory control of soil pests. The BHC dust improved the percentage of establishment from 74 to 92, and both aldrin dusts to 99, ten months after planting. The application of BHC dust costing Shs.17/50 per acre for the insecticide has become routine practice on estates where soil pests have been recorded in numbers.

Control of thrips and red spider on Meru is difficult as tractor-mounted sprayers cannot be used on the steep slopes and water for spraying is not obtainable in sufficient quantity. An effort has been made to reduce the general level of infestation by ensuring that planting material in the nursery is not infested when removed to the field. Rogor 0.04% spray has been found to give a very high degree of control of red spider. Its value against thrips has not yet been ascertained.

At Uwemba the main insect pest is thrips. A heavy infestation which apparently began to build up with the onset of the warmer weather in August caused severe damage. Preparations are being made to spray with DDT should the pest appear in numbers next year.

Sugar Cane: Chemical control of the red cane beetle, *Cochliotis melolonthoides*, is being obtained at Arusha Chini by using aldrin in the planting furrow. The degree of control in ratoon crops is not as satisfactory as desired and attention is being turned to the possibility of biological control.

Tobacco: Outbreaks of Anthracnose (*Colletotrichum tabacum*) at Urambo and Chunya reported at the end of 1957 were brought under control with zineb fungicides.

Cocoa: The chief pests found at the Maramba estate, Eastern Usambaras, were the sucking bugs, *Helopeltis bergrothi*, *H. anacardii*, and *Pseudotheraptus wayi* which cause severe damage to the fruit and the mealybug, *Planococcus citri*, which causes severe distortion of the plant by damaging the growing point. It is particularly troublesome on young trees. The following control measures have been advised:

(a) the use of 0.5% gamma BHC dust against *Helopeltis* and *Pseudotheraptus*;
(b) directed control of the mealybug using malathion or Rogor;
(c) the use of dieldrin as a band about the base of all trees to control the ant, *Pheidole*, attendant on the mealybug.

"Ring-barking" damage has been noted at the base of the branches, but no insect causing the damage has been found.

Coffee: Rust (*Hemileia vastatrix*), has again been severe in the main Arabica areas. In an experiment at Lyamungu, in which trees have been treated monthly with copper (oxychloride) sprays and insecticide to control leaf-miners, it was noted that leaf retention was markedly greater on the copper-sprayed trees both with and without insecticide. A number of *Hemileia* spots were present on the leaves of sprayed trees.

Weekly records at Lyamungu over the past two years have given a clear picture of the build-up of *Hemileia* infection in relation to rainfall. It is considered that at least five sprayings with conventional copper fungicides will be necessary to secure adequate protection of new foliage against the frequently recurring infections under the prevailing conditions. There are a number of factors that weigh against such a programme becoming general practice, the principal one being the high cost.

Bark disease, (Fusarium lateritium var. longum), is becoming increasingly important. Several deaths have been reported following infection in Rungwe District. On Kilimanjaro the disease has been found in constant association with a die-back of leaders on estates and African holdings. There is a suggestion that the fungus has gained entry via leaf scars and pruning cuts possibly during a wet period which has facilitated infection. Spraying with a fungicide to run-off immediately after pruning has been recommended as a possible method of control.

Cotton: Attention was given at Ukiriguru this season to the possibilities of improving the efficiency of seed treatment under commercial conditions. As a result of tests last season and further tests using the Booth drum, recommendations were made that the rate of "Perecot" application be increased from 1:250 w/w to 1:200 w/w and that the charging rate for the 35 cu. feet drum be reduced from 10 cwt to 8 cwt in order to achieve a more uniform coverage of seed. Both these recommendations have been put into effect.

In addition experiments were carried out on the use of mercurial formulations under commercial conditions. Fifty tons of UK.55 have been treated with "Abavit B" and it will be possible to make some assessment of the control of bacterial blight achieved during the coming season.

Two insecticide formulations were compared with the recommended "Cotton Dust" containing 10% DDT and 3% gamma BHC, in single and double rows of the same population. The treatments were:

1 lb DDT + 0.3 lb BHC
1 lb DDT + 0.3 lb gamma BHC
1 lb DDT + 0.1 lb malathion.

Yields were similar for both single and double rows but the double row made for easier operation both for dusting and harvesting.

The two formulations based on DDT and BHC have similar yields but that containing gamma BHC was appreciably more expensive. Although the DDT plus malathion was the most expensive formulation used the extra return obtained justified its use. Its advantage seemed to be that it gave additional control of bollworm as well as checking aphid build up.

In another experiment endrin at $\frac{1}{4}$ lb per acre per spraying gave a similar yield to that obtained by DDT plus BHC but was appreciably cheaper, about Shs.50 per acre. Pyrethrum sprays were also tested and whilst they restricted jassid breeding there was no discernible effect on bollworms. Since DDT is effective against jassid the addition of pyrethrins does not seem to be warranted.

(Annual Report of the Department of Agriculture, 1958. Part II (Research)).

ZANZIBAR

Malaria: The scheme for the eradication of malaria drawn up by agreement between the Government, the World Health Organisation and the United Nations Children's Fund was started in 1957 with a preliminary malariometric survey. Initial surveys showed, as was suspected, that malaria was hyperendemic throughout the Protectorate.

The spraying with dieldrin of all houses in the Protectorate, with the exception of those houses in the Stone Town area of Zanzibar town, was started in April, 1958. The first spraying cycle is expected to be completed in the early weeks of 1959 when a final total of over 100,000 houses will have been sprayed.

In addition to the spraying campaign in Pemba which began in November, 1958, a combined tablet of chloroquin and pyrimethamine was distributed to the whole population. This was begun in November, 1958, and will continue for six months.

(Colonial Office - Report on Zanzibar for the Years 1957 and 1958. H.M.S.O. 1959).

Maize: It is reported that stem-borers sometimes cause serious crop losses in the coral areas. In a trial, 5% DDT was effective in reducing the damage. Weekly applications were more effective than applications made at 2 or 3-weekly intervals. In the untreated plots only 11% of the plants showed no infestation while 70% were badly damaged or destroyed. In the plots treated at weekly intervals, however, 47% of the plants were unattacked and only 21% were badly damaged or destroyed.

Poultry Mite, Dermanyssus gallinae, Control: This mite caused much discomfort to householders in the north of Zanzibar for a short period. Even houses without poultry were affected. Of the insecticides tried "Agrocide" (BHC) was the most effective; used at the rate of about 1 lb for an average sized house it successfully cleared the mites from 262 houses.

Stored Products: The Department has been mainly concerned with prevention of the entry of *Trogoderma granarium* on imported foodstuffs and its destruction whenever found.

Inspection revealed 18 vessels to be carrying *Trogoderma*. The majority of the infested cargoes were fumigated in lighters prior to landing. This is an effective and convenient method, ensuring that the lighters do not infest clean cargoes when used subsequently. It was usually necessary to fumigate all cargo landed from a hatch containing infested cargo, whether or not it appeared to be infested, but clean cargo from a separate hatch was not fumigated. In order to safeguard the position on the mainland and as an internal control measure, used gunny bags and articles and merchandise wrapped in such material destined for Kenya and Tanganyika were fumigated before shipment.

Fumigation in all cases consisted of exposure to methly bromide at a minimum concentration of 3 lb per 1,000 cu. ft for a period of 24 or more hours. Fumigation was carried out by a commercial company. For fumigation in the godown the material was stacked and covered with sheets, the methyl bromide being led in under the sheets through piping.

Fifty one inspections of town godowns and oil mills were undertaken during the year. Three of these revealed infestation with *Trogoderma*. The contents of these godowns were removed and fumigated in the godown used for export fumigations, and the buildings were cleaned and drench sprayed with malathion. On re-use, the godown and produce stored therein were dusted with 0.5% BHC. For mixing with susceptible grain 0.04% BHC was used. This procedure of cleaning, spraying and dusting was also carried out in cases where severe infestation by pests other than *Trogoderma* occured or where *Trogoderma* was suspected.

(Annual Report of the Department of Agriculture 1958.)

NEWS ITEMS FROM OTHER PARTS OF THE WORLD

ARGENTINA

Deciduous Fruit: "Among the major fruit pests are oriental fruit moth, Grapholitha molesta Busck, and codling moth, Carpocapsa pomonella L., the former being more numerous than the latter on the Delta. Both species occur from October until May, and can cause losses of 30 to 50% on apples. However, they are well controlled with the aid of a forecasting service which was established in 1953. The forecasting is based on investigations carried out by the former Laboratorio de Fitopatologia del Delta, now integrated with the Estacion Experimental Agropecuaria del Delta. There are normally five to six warnings. For the first two treatments lead arsenate, at a rate of 350 grams per 100 litres of water, is recommended to control the basket worm, Oiketicus kirbyi Guild. For the subsequent three or four treatments, 0.125% DDT spray is suggested for its greater effectiveness against the oriental fruit moth. As a result, losses to apples have been reduced to 1 to 2%. Peaches may partially escape the damage of the oriental fruit moth, as only early maturing varieties are grown on the Delta.

During a warm autumn, Mediterranean fruit fly, Ceratitis capitata Wied., is prevalent, causing serious injuries to grapefruits, oranges, and some early maturing mandarin varieties such as Satsuma. Apples, are attacked from January to March but the insect is adequately controlled by observing the recommendations of the forecasting service. On peaches, the insect is found from December to February or March, and on citrus it appears in March and persists until the end of May or beginning of June, when the first frosts appear. Some growers use malathion with molasses as attractant for the control of the Mediterranean fruit fly, since protein hydrolizates are not readily available on the local market."

Citrus: "The following scale insects are of importance: California red scale, Aonidiella aurantii Mask.; the dictyospermum scale, Chrysomphalus dictiospermi Morg.; purple scale, Lepidosaphes beckii (Newm.); snow scale, Unapsis citri Comst.; the cottony cushion scale, Icerya purchasi Mask.; and the delta scale, Lecanium deltae Liz., mentioned previously. The presence of these pests requires repeated treatment with mineral oils, with or without the addition of phosphorus insecticides."

("Plant Pests and Diseases of Economic Importance in the Parana Delta, Argentina." M.V. Fernandez Valiela. F.A.O. Plant Protection Bulletin, July 1959, 7, (10), 129-133.)

HAWAII

Sugar-Cane

Pythium Rot: It is reported that the fungicide, Bayer 22555 (p-dimethylaminobenzenediazo sodium sulphonate) continued to look promising for the control of *Pythium* root rot of sugar-cane seedlings in flats. During the 1960 seedling season, it is proposed to replace captan with this material for preventing and controlling the disease at the rate of 0.2 g per flat of the 70% active fungicide, applied at weekly intervals. A flat contains approximately 1.9 square feet of surface soil with a depth of four inches.

The results of several greenhouse pot tests indicate that B 22555 is quite effective for controlling *Pythium* root rot of sugar-cane when added to the soil in two separate applications of 133 pounds per acre at biweekly intervals. The fungicide SD 4741 (a Shell Development Company product) did not control *Pythium* root rot and was found to be slightly toxic to sugar-cane at the rates used.

B 22555 appears to have a selective nematocidal effect, especially against the stubby-root nematode (*Trichodorus* sp.) at 133 pounds per acre. Further studies will be conducted against nematodes using lower rates of the fungicide as recommended by its manufacturer.

Eutochia lateralis Boh.: The larvae of this tenebrionid beetle, normally a minor pest, were unusually abundant in one area and prevented germination of about one third of the seedpieces in a one-acre experiment. The application of dieldrin granules, at a rate of three pounds of actual dieldrin per acre, was recommended as protection for the replant seed of the experiment and has apparently proved successful.

Rat Control: Two field tests of the endrin dog biscuit combination, developed in 1958, were conducted on Kauai and Hawaii, respectively. The first of these tests was attended by unfavourable circumstances and failed to produce significant results. The second test, larger than the first and in a more propitious environment, verified laboratory conclusions as to the value of the new rodenticide in combatting rats, particularly the Norway rat, in areas inaccesible to ordinary measures.

The endrin biscuits employed in the two tests were obtained through the cooperation of the Pacific Chemical & Fertilizer Co., the Velsicol Corporation, and the manufacturers of the original dog biscuit bought in the open market for the tests of last year. The formula of their composition is said to be identical with that of the pet food, but their size and shape are better adapted to the functions of a carrier which will be broadcast mechanically or by hand. They are shaped like oyster crackers of a half-inch diameter, weigh an average 2.8 grams per unit, and at a concentration of 2.5% endrin by weight, carry enough poison to kill more than 30 of the largest Norway rats. It is believed that for maximum effect they should be broadcast at a rate of about 10.75 pounds to the acre. This should result in a distribution of one biscuit for every five-foot square, and cost about $4.80 per acre for materials.

In the test conducted at Olaa, the baits were hurled by hand to both sides of paths cut through cane approximately 22 months old. One of the paths was 1000 feet long and the other 950 feet, and the average width of the area treated was estimated at about 50 feet, so that the biscuits were distributed at a rate of one for every 19 square feet, which is considered an unnecessarily high density.

The effect of the application was judged by comparing the results of pre-treatment and post-treatment trapping along the two paths and along two check lines laid in the same area of the field. The trapping, simultaneous along the four lines, was done on the two days immediately preceding the treatment, and on the sixth and seventh day following the treatment.

Analysis of the results shows a reduction of 72% in the combined populations of the two test areas, against a reduction of 15% in the combined populations of the two check areas. Ideally, no change should have appeared in the checks; but in the case of this particular test, the slight reduction observed does not diminish the significance of the much greater reduction measured in the test areas. This contention is based on the fact, evinced by the results themselves, that the check areas were not fully representative of the test areas, either in the composition or the density of their rat population. The contention is further strengthened by the strong probability that the checks were too near the test areas to escape completely the effect of the poison.

The larger reduction of female Norways (83%) than of Norway males (62%) is in accord with experience of endrin characteristics and indicates that the over-all reduction in the treatment areas was due to this poison. Reduction by other factors was not likely to have resulted in a sexually differentiated ratio.

Laboratory experience has shown that most rats succumb quickly to the effect of endrin biscuits, but that there is always a considerable segment of the population which takes longer to die, in some cases several days. It is reasonably certain, therefore, that the results of the present test do not represent the maximum kill that could have been measured if the post-treatment trapping had been delayed a week or longer beyond the dates when it was actually conducted. This was done for fear that encroachment of unpoisoned rats from the surrounding area would vitiate the results more than early trapping.

In an experiment involving a large area, particularly a discrete area, need for this precaution would have been obviated, and the results would have been more striking.

This consideration seems to justify the conclusion that endrin biscuits possess high potential value in the control of rats, particularly Norway rats, in overgrown cane fields and other areas not within reach of ordinary abatement measures.

(Hawaiian Sugar Planters' Association, Experiment Station Report, October 1, 1958 to September 30, 1959.)

JAPAN

Housefly Control: Tests were carried out in semi-farm villages in Nagasaki City during 1957 and 1958 using residual sprays and impregnated cords. Diazinon impregnated cords proved to be more efficient than residual sprays, though requiring a longer period to become effective. Cords impregnated with 5% diazinon, or 2.5% DDT with 2.5% diazinon, are recommended for use in living quarters, restaurants or hotels. (Endemic Diseases Bulletin of Nagasaki University, Sept. 1959, 1, (3)).

TURKEY

Tests with O.P. Insecticides: The effect of sunlight on the O.P. substances "Dipterex", "Isochlorthion" and "Chlorthion" was studied with reference to the test insect, *Aelia rostrata* (Hemiptera, Pentatomidae). It was found that sunlight reduced the biological effect of the insecticides; also that female insects were less susceptible than males.

(Bitki Koruma Bulteni, (Plant Protection Bulletin), Aug. 1959, 1, (1).)

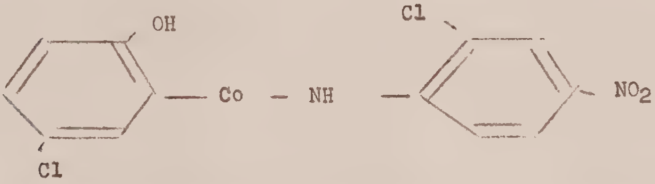
PROPRIETARY DATA

BAYER 73

Farbenfabriken Bayer Aktiengesellschaft, Leverkusen.

Further particulars of molluscicide Bayer 73, first introduced at the 6th International Congresses of Tropical Medicine and Hygiene, have been received from the manufacturer.

The active ingredient is



2-hydroxy-5, 2'-dichloro -4-nitrobenzanilide, which is a grey-yellow, odourless and almost tasteless powder, melting at 222-224°C, and of 93-100% degree purity. The compound is normally supplied in the form of its ethanolamine salt to improve the solubility in water. This derivative (Bayer 73) is a yellowish powder containing 16% ethanolamine. The salt is comparatively stable to UV irradiation and to mild alkali (pH 7-10). It is only slightly absorbed on organic substances and remains fully effective for at least 24 hours under laboratory conditions, to temperatures ranging from +4°C to +30°C. A 70% active wettable powder of molluscicide Bayer 73 (known as test product 4780) has been developed for field tests.

Biological Effect: The product is markedly effective against aquatic snails. It will act on amphibian snails only when they are immersed. It has been shown to kill *Australorbis glabratus* under laboratory conditions at concentrations of 0.3 ppm. In tests carried out in the Philippines, molluscicide Bayer 73 was found to be fully effective against PCP-resistant *Oncomelania quadrasi*.

It has so far been established that the effect of molluscicide Bayer 73 is partly due to a blockage of the oxygen uptake of the snails. Therefore, the effect may vary according to the oxygen requirements of the snails. Test results obtained to date have revealed that snail spawn is also killed by molluscicide Bayer 73 at the dosage required to control adult snails.

Summary of Laboratory Results

Species	% mortality	Time (hours)	Concentration ppm
Taphius (*Australorbis*) *glabratus*	100	24	0.3, 0.4
Oncomelania hupensis (in water)	100	24	0.3
Lymnea palustris	100	24	0.3
Lymnea ovata	100	24	1.0
L. natalensis	100	12	1.0
Biomphalaria pfeifferi nairobiensis	100	12	1.0
Bulinus tropicus	85	12	1.0
Poecilia januarensis	86	48	0.8
	100	2	1.6

The compound is found to be ineffective against Culicidae larvae at the dosages toxic to snails. Dosages of over 1 ppm proved toxic to the fish Lebistes reticulatus and Xiphophorus helleri. Frogs and their larvae, also Daphnia, are killed at concentrations required to control snails.

Phytotoxic Effect: It appears harmless to rice, oats and sugar cane and to underwater vegetation at the concentrations required for practical application.

Mammalian Toxicity:

Test subject	Doses tolerated (g/kg)			
	Per os	Interperitoneal	Subcutaneous	Per os chronic
Rat	5	0.5	1.0	No symptoms at 12 x 1.0
Mouse	2	1.0	2.0	-
Rabbit	5	-	-	No symptoms at 12 x 1.0
Cat	2.5	-	-	
Human	per os 2 x 1 g/60 kg at intervals of 1 hour, very well tolerated. No secondary effects (20 persons.)			
Cow	A cow weighing 230 kilos was given a dosage of 2.3.g per os each day for a period of 93 days (total of 223.9 g) and at the end of the test its growth and increase of weight had not been affected.			

Field Tests: These are at present being conducted in Africa, Asia, Central and South America. Preliminary results from Kenya are described by Foster, Teesdale and Poulton in C.P.R.U. Arusha Misc.Rep.No. 232. A report from the Belgian Congo indicated that 100% mortality of snails and spawn of Planorbis and Limnea had occurred within 8 hours in a stream dosed over a distance of 7.7.km at a concentration of 4.2 ppm. Further trials at lower dosages are planned.

CHEMICAL HYGIENE FELLOWSHIP

Union Carbide Chemicals Comments, 1960, 10, (1).

On November 29, 1937, Union Carbide Chemicals Company contracted with Mellon Institute to sponsor a Chemical Hygiene Fellowship at the Institute's headquarters in Pittsburgh, Pennsylvania, Here, a pair of rooms was allotted to two scientists, who began studies in applied toxicology and other subjects relating to the safe production, handling and use of chemicals.

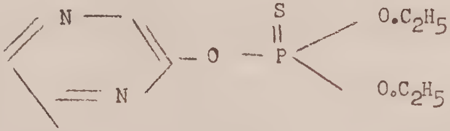
The Fellowship is now located at Bushy Run, Mellon in a building, officially opened in September 1959, having 30,000 sq.ft.

In order to predict the toxicological characteristics of a given chemical, the Fellowship conducts series of experiments on animals. Among other things, these experiments determine: effects of the chemical on the eye; effects of vapour inhalation; effects of ingestion (with the help of micropathological and hematological studies); and effects of skin contact, including degree of irritation, sensitization, and absorption of the test material through the skin. An important part of the work of the Fellowship is concerned with determining safety, for use in food of packaging materials and food additives of either intentional or incidental nature. Insecticides and fungicides which might enter into foods are also studied extensively.

Animals used in toxicological studies are usually rodents - mice, rats, hamsters, guinea pigs, and rabbits. Larger animals are used only when rodents do not suit the purpose; and in all cases, every consideration is given to the comfort and well being of the animals. Data obtained from animal experiments have been extremely valuable in promoting safety throughout the chemical industry.

EXPERIMENTAL NEMATOCIDE 18,133

Agricultural Division, Stamford Laboratories, American Cyanamid Company.



(O,O-diethyl O,2-pyrazinyl phosphorothioate)

This compound, which is a liquid (density 1.207; N25/D, 1.5100) has exhibited, on a research scale, ability to control plant parasitic nematodes and soil insects, in such crops as tobacco, peanuts, corn, strawberries and citrus. It may also be suitable for the control of symphylids. A particular advantage of this compound is that it can be used in the presence of living plants and seeds; it can be applied with standard spreading or spray equipment. Its effect is not attributable to fumigation and depends upon water movement for redistribution in the soil following mechanical mixing. (The best movement will occur in sandy soil, which, incidentally, is the soil type in which most serious soil nematode problems occur.)

Toxicology: Its mammalian toxicity is qualitatively and quantitatively comparable to that of parathion. The utmost care must therefore be exercised in its handling since the compound is as hazardous by skin contact as by ingestion or inhalation.

Application: The compound has been found to possess practical nematocidal activity at rates *as low as* 4 lb technical per acre, when applied in a furrow to sandy soil. Planting may proceed concurrently with treatment or be delayed for about 3 weeks. Fall applications to tobacco plant beds have controlled root-knot nematode satisfactorily. The compound should be mixed as deep into the soil as practical. In the field more satisfactory nematode control has been obtained in sandy soil than in soils high in clay content.

Formulation: The compound is miscible with acetone, alcohol and most organic solvents. It is not more than 0.1% soluble in water. For experimental work EN 18,133 is being formulated as a 5% granular. In some instances 1.5% and 10% formulations are available. Where drench applications are to be made the emulsifiable concentrate (4 lb a.i. per U.S. gal) should be used.

Susceptible Nematodes: Evidence to date indicates that the following species are controlled:

Root-knot nematode	- *Meloidogyne* sp.
Sting nematode	- *Belonolaimus gracilis*
Stunt nematode	- *Tylenchorynchus* sp.
Bulb and stem nematode	- *Ditylenchus dipsaci*
Citrus nematode	- *Tylenchulus semipenetrans*
Soybean cyst nematode	- *Heterodera glycines*
Sugarbeet nematode	- *Heterodera schachtii*
Root lesion nematode	- *Pratylenchus* sp.

Plant Tolerance: The tolerance range for many species has yet to be established, particularly under field conditions. Evidence at present indicates that the following plants have considerable tolerance to soil treatments of EN 18,133. In a very limited number of instances applications were made to the foliage of established plants without apparent phytotoxicity at the rates used. The tolerance limits have not been established under varying environmental conditions and soil types, hence care should be exercised in the selection of rates. Excessively high rates (over 20 pounds per acre of actual EN 18,133) should not be used except when attempting to determine the tolerance limit of the particular species in question.

Soil treatment: Alfalfa, citrus, corn, cotton, cucumbers, grapes, lettuce, onions, peaches, peanuts, peony, pine (slash), radish, rice, spruce, strawberries, sweet potatoes, tobacco, tomatoes, wheat.

Foliage application: Bentgrass, bluegrass, zoysia grass, grapes, spruce.

Insecticide Performance: The insecticidal activity of EN 18,133 as evaluated in the laboratory and field is comparable to "Thimet" (R), phorate and parathion in many respects. The control of certain soil borne insects such as onion maggot, southern potato wireworm, carrot rust fly and pineapple root mealybug has been sufficiently encouraging to stimulate expanded research on these and other soil insects.

Further particulars, suggested experimental procedures, specimen record sheets, and samples, are available on request from the manufacturer. (U.K. address = Cyanamid of Great Britain Ltd., Agricultural Division, Bush House, London, W.C.2.)

KESTREL SPRAYING AND DUSTING EQUIPMENT

Kestrel Engineering Co. Ltd., 222 Soho Hill, Handsworth, Birmingham, 19.

Knapsack Sprayer: A hand operated, lightweight sprayer (under 9 lb when empty) obtainable in 2, 3 and 5 gal capacities. The container is of polythene which is durable, non-corrodible and easily cleaned. The standard lance (24") is polythene lined and telescopic lance attachments in duralumin, also polythene lined, are available in 6', 9', 12' and 15' lengths. Accessories supplied include nozzle and boom attachments, and apparatus for glass cleaning.

Power Sprayer: The frame is of welded steel construction, fitted with ball bearing wheels and pneumatic tyres. Size 20" x 4". The engine is a four-stroke B.S.A. 98 cc., 6-1 gear ratio. The pump has bronze gears and body, with stainless steel shafts. Capacity - 240 G.P.H. at 100 p.s.i. It is fitted with an easy-clean filter and adjustable pressure control valve with pressure gauge. The container, of 13 gallons capacity, is easily detachable: made in unbreakable and uncorrodible polythene. Hydraulic agitation is provided. The manifold is fitted with two plug-in type sockets as standard, though any number up to 6 may be had, to order. The Kestrel Telescopic Lance and all standard lances and other attachments can be supplied to individual requirements.

The boom has 6 jets, giving a spray width of 6 feet, as standard. An 8 jet boom, giving a spray width of 8 feet, is available to order. A detachable lightweight roller boom is a special feature of the Power Sprayer. It has been developed for use on golf greens, bowling greens, and for any turf of a delicate nature, where a heavy machine might well cause damage.

Knapsack Duster: It is described as readily portable, light to wear and easy and comfortable to operate. It is reported to have been rigorously tested both at home and abroad, with trouble-free use in all climates. The following features are noted: suitability for all powders; regulator to control the powder flow; a direct feed principle to prevent dust blockages. Extra lengths of delivery tube to dust up to height of 20 ft. can be supplied to order.

Power Duster: This comprises:

Engine: B.S.A. or B. & S. air-cooled 4-stroke, developing 2.2 or 2.7 h.p. respectively at 3,000 r.p.m. Normal working speed 3,000 r.p.m. Magneto ignition. Consumption, ½ gal approximately per 1½ hours at 3,000 r.p.m.

Fan: Accurately balanced and specially designed for high pressure. The fan is fully floating and has an output range that will dust the highest trees or any root crop.

Hopper: Has a capacity of 56 lb or 112 lb for sulphur and for other powders according to density.

Feed: Direct through the fan by mechanical agitator. Powder-feed is controlled by a positive regulator that can be pre-set to give the required amount up to 10 lb per min.

Weight: With frame but unladen, less than 60 lb.

General: It is stressed that there are no bearings or any wearing parts on the Kestrel Duster other than those in the engine. Maintenance costs are therefore negligible. Can be supplied with a two or four wheeled chassis as an optional extra. An efficient dynamo lighting set with four lamps can be supplied at a moderate extra charge.

LOCUST CONTROL WITH "SEVIN"

Agricultural Chemicals Digest, 1, (4). Union Carbide Corp.

The Bureau of Plant Industry of the Philippines recently conducted field tests using "Sevin" insecticide on migratory locusts (Migratoria manilensis). Preliminary results indicate "Sevin" to be highly effective. Against many of the pests, kill was effected immediately.

The experiment, held on the island of Mindanao, was conducted under the supervision of Mr. Victorino Madrid, Entomologist of the Bureau of Plant Industry. The site of the field test was outside Dadiangas and the area tested was approximately 1,000 square meters. A power sprayer mounted on a jeep was used to treat the area. A spray concentration of 120 grams of "Sevin" dispersed in 50 gallons (189.2 liters) of water was sprayed on a swarm of locusts (hoppers) crossing the road at the site of the experiment. Thirty minutes after the application, "Sevin" had noticeable effects on the locusts and two hours after the experiment dead locusts were found along the side of the road to a distance of 5 metres in the field.

Results of this experiment were so outstanding that Dr. Madrid outlined a programme for additional field tests in the near future. The next experiment will use "Sevin" as the active ingredient in a bait. The bait will be composed of rice hulls, sea water (or molasses) as attractants and the active ingredient mixed together. The bait will be strewn on an open field near a swarm of locusts. Another test will find "Sevin" sprayed on adult locusts (fliers) at various concentrations. In another field test programme in the mid-western United States, granular "Sevin" applied by air to the breeding grounds gave excellent results on the salt marsh mosquito (Aedes sollicitans.)

MIST-O-MATIC LIQUID SEED TREATMENT

British Schering Ltd., 229/231 Kensington High Street, London, W.8.

Hitherto the application of a chemical treatment to seed was basically the same, irrespective of whether the treatment applied was a powder or a liquid dressing i.e. a quantity of the treatment is dropped or dripped on to the appropriate quantity of seed and then an attempt is made to distribute the treatment evenly over the seed by mechanical mixing in a revolving drum. This method of distributing the treatment might work fairly satisfactorily with powder dressings but when liquid seed dressings are applied in this simple manner at a rate of one fluid ounce per bushel which is roughly equivalent to one drop of the liquid to 4,000 seeds, it is considerably more difficult to obtain uniform distribution of the treatment.

The method, up to date, of tackling this problem of distributing small quantities of chemical over large quantities of seed is to depend upon the use of volatile mercurial compounds. By the use of these compounds, uneven distribution of the liquid is largely overcome by the subsequent vapour action of the volatile mercurial compound used as the seed treatment. This vapour action, however, will be dependant upon certain climatic, atmospheric and storage conditions for optimum effect and it will not, of course, operate in the case of the relatively non-volatile insecticidal liquid seed treatment. For maximum efficiency, therefore, it is important that the initial distribution of the chemical seed treatment should be as even as possible.

By the "Mist-O-Matic" method of liquid seed treatment, the small quantities of the liquid dressings are atomised into a very fine, penetrating, spray mist through which the seed to be treated has to pass. This spray mist is retained in the atomising chamber and as the seed passes through this chamber every seed comes into contact with thousands of 'mist-size' particles which colours the seed a distinctive red.

The "Mist-O-Matic" machine is capable of treating seed at a rate of up to nine tons per hour, the actual through-put will, of course, depend upon the rate at which cleaned seed is fed to it. As the grain flows into the machine it alternately fills each one of two seed pans. When these contain the correct amount of seed, as regulated by the setting of the counterweight, the pan tips and the other pan is then filled. This intermittent flow of grain is converted into a uniform flow by means of retarders. From the retarders the grain falls over the cone spreader into the atomising chamber. The spindle of the seed pan hopper is connected to an arm carrying two stainless steel cups. When the seed pan empties it tilts the connecting arm of the liquid feed mechanism and the contents of one of the cups is decanted down the liquid feed line to the atomising disc in the seed treating chamber. The physical properties of the specially formulated liquids and the construction of the feed line in the "Mist-O-Matic" machine ensures an even flow of liquid to the atomising disc. The level of liquids in the metering tanks is maintained by a small pump which draws the liquids from the containers in which these liquids are supplied. Excess liquids return to the containers by means of an over flow. There are two metering tanks, one for the mercurial liquid ("Mist-O-Matic" Mercury Dressing) and the other for the insecticidal liquid ("Mist-O-Matic" Wireworm and Wheat Bulb Fly Dressing). For dual purpose protection against seed borne diseases and wireworm the two liquids are applied simultaneously. When changing from a dual treatment to a straight mercurial treatment it is only necessary to open a by pass valve and allow the insecticidal liquid to drain from the metering tank back to its container. In order to treat the seed for wheat bulb fly control larger measuring cups are quickly inserted so that a double dose of the insecticide treatment is given. The pumps and atomising disc are all driven by means of a $\frac{1}{3}$ H.P. single phase electric motor.

Uniform distribution of the chemical is essential for effective seed treatment. By the "Mist-O-Matic" method, every seed is treated at the time of application of the chemical in the seed treating machine and there is less risk of uneven treatment application resulting in 'over dressing' phytotoxic effects and of some seeds being inadequately protected against wireworm and wheat bulb fly attack. The unique atomising process in the "Mist-O-Matic" machine ensures even distribution of both the fungicidal and insecticidal constituents of the liquid seed dressing. By so doing it also does away with the necessity to use volatile mercurial compounds, which give off poisonous vapour not only when being applied in the seed treating machine but also from the seed after treatment.

"Mist-O-Matic" Mercury and "Mist-O-Matic" Wireworm and Wheat Bulb Fly Liquid Seed Dressings are manufactured by British Schering and "Mist-O-Matic" machines are being offered to merchants at a purchase price of £200 or at a rent of £40 per year. The costs of the liquid dressings are comparable with the powder dressings. (C. P. Hampson).

MURPHY FRUIT GROWER'S BOOKLET 1960

Murphy Chemical Co. Ltd., Wheathampstead, St. Albans, Herts.
124 pp. illustrated.

Revised edition. Two new pest control materials have been added to the range of products already marketed by Murphy, viz.:

Sevin (1-naphthyl N-methylcarbamate) as 50% W/P particularly recommended for codling moth control;

Thiodan (6,7,8,9,10,10-hexachloro-1,5,5a,9,9a-hexahydro-6,9-methane-2,4,3-benzodioxathiepin-3-oxide) as 17.5% miscible liquid for the control of big bud mite.

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ABSTRACTS

WEST AFRICAN COCOA RESEARCH INSTITUTE.
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Pathology Division

Fungicide spray Control Trials

An experiment has commenced to examine the possible use of light mineral oil to control black-pod disease. Spraying at three-weekly intervals and six-weekly harvesting of the Upper Amazon Spacing and Pruning Trial commenced on 10th April, 1959. The first two oil applications were with Shell S2686 (U.R.95) and the remainder with Shell "Vapona E."(U.R.96).

Entomology Division

Mealybug Studies

A trial to test the efficiency of different formulations and methods of application of dieldrin to control ants, has been laid down at Bunso, Bosuso and Osino areas. It is intended that the following treatments will be applied.

1. Trunk application of 0.67% solution (1 lb toxicant in 20 gallons of water) with a motorised mist-blower sprayer to the first 8-10 feet of trunk; the volume applied being geared to the tree density rather than acreage.

2. Spray-banding using a 1.25% solution (1 lb toxicant in 10 gallons of water) applied with pressurised knapsack sprayers to a 2 ft deep zone round the trunk of each cocoa tree. It is envisaged that where areas of primary and secondary forest occur within a plot they will have to be treated with motorised mist-blower sprayers as in 1.

3. Trunk-banding applied with a paint brush using a 10% urea formaldehyde-dieldrin lacquer (Tapley's formulation as used against coffee stem borers in East Africa).

4. Lower trunk and ground litter application with a 1.25% solution; applied with a baffled motorised mist-blower sprayer in such a manner that will prevent upward drift into the tree canopy.

5. Untreated control.

Pre-treatment counts of ant and mealybug populations, to hand-height, have been made on all the plots. Further ant and mealybug population counts will be made at fortnightly intervals for the duration of the experiment.

The incidence of minor pests, and in particular, the mining and wood boring species, will also be recorded to observe any changes in population balance which may result from the different types of treatment.

THE RELATIONSHIP BETWEEN INSECT DAMAGE, CROP FORMATION AND THE FINAL YIELD OF COCONUTS

K. S. McKINLAY. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous report No. 255.

An experiment is described in which three plots of 50 palms each were protected against insect damage (Pseudotheraptus) and three plots were left as untreated controls. In order to facilitate the collection of fallen vidaka (young nuts less than three inches long) the experimental plots were clean cultivated and have been kept clear of all vegetation ever since. It was felt that clean cultivation might in itself affect the yield of the palms since the plantations as a whole are not normally cultivated but often left with a natural cover of grass and small bushes. Therefore fifty palms on uncleared ground adjacent to each experimental plot were marked and have been harvested in order to assess the effect of clean cultivation upon yield.

Climbers using small pressure-retaining knapsack sprayers applied three pints of a mixture of 0.1% of DDT and 0.1% malathion emulsions in water to the crown of each palm. Whilst the DDT alone could be expected to control Pseudotheraptus the addition of malathion was thought necessary to avoid any risk of build up of scale insects. This method of protection is obviously uneconomic and is entirely determined by the design of the trial where it is necessary to protect small replicated plots from a mobile pest. (Unpublished data from Vanderplank and the Colonial Pesticides Research Unit suggest that large areas in excess of 100 acres, can be protected either by mist blower or aircraft applications of insecticides at three-monthly intervals.)

The results of the experiments are presented in eight tables. The author concludes:

"In general the relationship between damage by Pseudotheraptus and yield has been found to be complex and probable increases in yield due to pest control are difficult to predict. Whilst the experiment will have to be continued for several seasons to assess the overall effect, the results do suggest that the increases to be obtained through controlling Pseudotheraptus are not going to be as large as had been anticipated, and that a much more consistent increase in yield might be obtained by improved methods of cultivation."

THE ECONOMICS OF SPRAYING COCONUTS FROM THE GROUND IN ZANZIBAR

B. H. HYDE-WYATT. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 257.

with a "NOTE OF THE POSSIBILITY OF INCREASING COCONUT YIELDS BY CONTROLLING PSEUDOTHERAPTUS". by K. S. McKINLAY

An estimate of the costs involved in spraying coconut palms from the ground is given from data based on an experiment being conducted at Kidichi on the control of Pseudotheraptus wayi. The machine used is a Long Ashton mist-blower towed and powered by a Ferguson petrol-engined tractor.

The factors taken into account include: initial costs, maintenance and depreciation, running costs, applications and insecticide, shamba costs and yields. (Insecticide costs are based on the use of 10 DRDK - 10% DDT plus 1% resin in a 50% power kerosine: 50% dieseline mixture - applied in four double applications at 1½ gal/ac per application.)

In discussion the author states that the total cost of spraying an area of 780 acres works out at approximately £4,519 per annum, or £5. 16. 0. per acre, of which a little over 80% is the cost of insecticide.

He concludes that "on the basis of the figures quoted it would appear that the spraying of coconut palms from the ground is a practicable proposition provided only that an increase in yield of some 60% is achieved by the spray. That P.wayi can be kept down to a low population density has been demonstrated both at Tanga in Tanganyika, and at Kidichi in Zanzibar. Unfortunately in neither case has any satisfactory sustained yield increase resulted, casting grave doubts as to the importance of P.wayi as a pest of coconuts and the value of attempting its control."

In the accompanying note McKinlay states: "Whilst one can not say at the moment that a yield increase of 60% is impossible all the indications are that it is most unlikely and present results suggest that consistent increases in yield are much more likely to be obtained by persuading the grower to adopt higher standards of cultivation. The rank growth of grass and bushes, so common in many coconut areas and mentioned above as an obstacle to the use of the Long Ashton mist blower may well be causing more loss of yield than *Pseudotheraptus*."

COTTON PEST RESEARCH SCHEME (C.D.W. SCHEME R817) ANNUAL REPORT FOR THE 1958/59 SEASON (ABRIDGED).

Authors' Summary

Considerable data on the life history of *Diparopsis* has been obtained, which will be of great value for the development of control measures.

Egg mortality has been shown to be extremely high at certain times. Under field conditions the incubation period is 6-13 days although the time of hatching remained between 04.00-08.00 hours.

The 1st instar larvae wander for a sufficiently long period before penetrating the plant to be exposed to insecticide deposits for a reasonable period. During development larvae have been shown to construct a protective cell at the site of penetration, exhibit 're-entry' movement and transfer to fresh food, and when fully developed to drop from the plant and move away to pupate.

Mortality, caused by ants, including *Pheidole megacephala* F. was of considerable importance at all stages in the life cycle.

Pupation experiments have shown the importance of early build-up of *Diparopsis* infestations if cotton is ratooned. Overwintering pupae formed in increasing numbers towards the end of the season give rise to moths from October to March the following season, with a small proportion carrying over to a further season. Pupal development at 75-85°F gives rise to moths over a period of twenty weeks. Depth of pupation affects the date at which moth emergence commences without affecting the length of the emergence period.

This year's insecticide trials confirmed that substantial increases in yield can be obtained by spraying endrin regularly with a minimum number of 8 applications, provided that there is a high potential yield. However, infestations of *Heliothis* were more

effectively controlled by DDT. Sevin was used on a laboratory and field scale and shown to be very effective in controlling *Diparopsis*.

Cotton yields were extremely good in the Lower River, despite late planting rains. Cotton stainer populations built up too late in the season to cause any considerable damage. The *Sterculia* eradication experiment indicated that the stainer population during the critical March-April period was lower in the centre of the area cleared of *Sterculia* trees for the 1958/59 season.

Platyedra gossypiella Saund. was recorded for the first time in Southern Rhodesia on cotton and *Hibiscus congolensis*.

THE EFFECT OF SIMULATED INSECT DAMAGE ON THE YIELD OF THE COTTON PLANT

K. S. McKINLAY. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 256.

"It is well known that when the cotton plant is damaged by insect pests such as *Lygus* and bollworms which cause the loss of fruiting points that this damage does not always result in a corresponding loss of yield. This has been discussed in some detail by McKinlay and Geering (1957) and a further example is given by Valentine (1957-58) amongst others. Up to the present this problem has been investigated by either protecting the plant against the naturally occurring insect pests for varying periods by the use of insecticides or else using insecticides to afford complete protection against insect damage and removing all the flower buds manually for varying periods. It was felt that both methods had their limitations. In the first instance the amount of damage done depended upon the local insect population and was apt to be variable and not easily recorded. In the second case all flower buds were removed for varying periods whereas the insect pest usually removes only a proportion of the buds present at any given time. Therefore in the present experiment the attempt was made to duplicate more closely what might happen during a normal season when a pest such as *Lygus* or bollworm was attacking the cotton. A plot of cotton was protected against insect damage by weekly run-off sprays with 0.1% DDT emulsion to which 0.02% metasystox was added on several occasions to prevent damage by red spider. It was then assumed that under most conditions cotton would receive protection from insect damage by the use of insecticides for an eight-week period starting with the opening of the first flowers. Thus when flowering commenced the numbers of flower buds present each week were counted and varying proportions (up to 40%) of them removed by hand. The crop was harvested in fourteen weekly picks.

There were no significant differences in total yiedls between any of the treatments but the debudded plants yielded significantly less crop than the untreated controls in the first half of the harvest and significantly more in the second half. The results demonstrate once again that the cotton plant has very considerable powers of recovery from insect damage even in a year of rather poor rainfall. However, it should be remembered that there are areas where bollworm may remove much more than forty percent of the flower buds, and that the damage may not cease after eight weeks, thus allowing the damaged plants to recover by setting a top crop.

The amount of recovery possible will obviously depend upon many factors such as the length of the growing season, the duration and intensity of the insect attack, and how well the cotton is grown, and it will be very difficult to predict just when the use of insecticides would be profitable in any given situation. The results do suggest, however, that a great deal of damage can be done to the cotton plant without affecting the final yield."

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WEST AFRICAN INSTITUTE FOR OIL PALM RESEARCH
SEVENTH ANNUAL REPORT 1958-59.

Freckle of Oil Palm (Cercospora Leaf Spot)

During the period 1957-58, regular sprayings at three-weekly intervals have been carried out at the Main Station using ziram and captan (Orthocide 50W). A very good control of the disease was achieved until the last three months when the very vigorous growth of the seedlings in the nursery made it difficult for the sprayer to walk down the rows and achieve satisfactory cover of fungicides, especially on the lower surface of the leaves. As a result there was an increase in *Cercospora* infection in the nursery.

Field spraying trials carried out over the last four years have shown that of all the fungicides tested, a particular ziram-type fungicide proved to be the most efficient. Unfortunately this fungicide is no longer being manufactured and it was necessary to find another organic fungicide which would give the same measure of control. Although captan had never been tested at W.A.I.F.O.R. Main Station it has been used in the Belgian Congo where it is said to give as good a control as ziram. It was decided, therefore, that captan should be used for routine nursery spraying, and that at the same time field experiments designed to test the efficiency of this fungicide against ziram should be carried out.

Trials: The first trial was designed to compare the efficiency of the three fungicides, ziram, Orthocide 50 W(captan) and Phaltan 50W. The fungicides were applied at one, two and three-weekly intervals at two concentrations (2 lb and 4 lb per 100 gallons of water). A 3 x 3 factorial design with blocks of nine plots with four replications was used. All whole plots were split into sub-plots for the two concentrations. There were fifty seedlings per whole plot.

Although differences in both frequency and rate of application were significant, the difference in the mean score per seedling was very small and these results are insufficient to justify an alteration in the policy of spraying at a rate of 2 lb/100 gallons every three weeks.

In a second spraying trial Orthocide 50W (captan) and Phaltan 50W were applied at two concentrations (2 lb and 4 lb/100 gallons water), Perenox was applied at 1 lb/100 gallons and ziram at 2 lb/100 gallons. There were two untreated control plots. The experiment was laid out on an abandoned agronomy nursery area planted in 1957. Seedlings were removed to give a density of sixteen plants per plot, leaving 8 ft between plants. The design of the experiment was a randomized block with four replicates.

Statistical analysis showed that (1) all sprays produced a significant reduction in the amount of *Cercospora* infection, (2) Orthocide 50W, ziram and Phaltan 50W were more efficient than Perenox, and (3) there was no significant difference between rates of application for either Orthocide 50W or Phaltan 50W.

Anthracnose

Regular spraying against this disease was carried out at two-weekly intervals using captan at a concentration of 2 lb per 100 gallons of water. The use of fungicides and improved raised-tray practices has reduced the disease to a level where it is no longer of any economic importance.

INVESTIGATIONS ON THE HABITS OF QUELEA BIRDS AND THEIR CONTROL

J. W. HAYLOCK. Department of Agriculture, Kenya. 1959, pp. 16.

The author surveys the *Quelea* problem in East Africa and its economic significance to Kenya, where infestations have occurred every year since 1952 threatening the existence of small grain growing over large areas.

The work of the small unit based on the Scott Agricultural Laboratories at Nairobi, which is responsible for *Quelea* research and control in Kenya, is described. Its work includes biological and ecological field investigations including migration and population surveys. Reference is made to their search for more efficient methods of chemical control, partly in conjunction with the C.P.R.U. Arusha and the Entomological Section, Scott Laboratories, and to exchange of information with specialists in other African countries and with the C.C.T.A./C.S.A. at Bukavu.

An outline is given of standard control procedures. It is thought likely, however, that "until new methods are developed to reduce their overall numbers, this highly adaptable bird will meet control measures by more rapid breeding and changing habits".

An account of the *Quelea* breeding colony campaign, arising from a meeting held at Arusha in March 1959, is appended.

WEST AFRICAN COUNCIL FOR MEDICAL RESEARCH
ANNUAL REPORT 1958-59

Chrysops Control

Laboratory tests to compare the susceptibility of late *Chrysops* larval instars to water emulsions of dieldrin, DDT, gamma BHC and aldrin have now been completed. The larvae were exposed to different concentrations of the insecticides for a period of ten minutes and the mortality assessed over the ensuing 24 hours. Dieldrin was shown to be the most potent of the insecticides tested, the LD50 for *Chrysops* larvae being between 0.01% and 0.025%.

Throughout the year samples of mud, collected at intervals from natural breeding sites previously treated with the various insecticides, have been sent to the Colonial Pesticides Research Unit at Arusha, Tanganyika, for analysis. One series of sites was sprayed early in the dry season and another series at the beginning of the heavy rains. The results of chemical analyses received so far indicate that dieldrin is the most persistent insecticide in the field. Of all the sites, which for the purpose of these experiments were sprayed with 2.5% emulsion of the insecticide active principle at the rate of four pints per 100 square feet, only those treated with dieldrin were completely free from Chrysops larvae one year after spraying. Bio-assay experiments have shown that mud from the sites treated with dieldrin has a definite lethal effect on Chrysops larvae up to nine months after application of the insecticide.

The results obtained in the laboratory and in the field indicate that on grounds of toxicity to larvae, persistence and cost, dieldrin is the insecticide of choice for use against Chrysops larvae. It is now necessary to determine the minimum strength of the insecticide that will be effective in the field, thus determining the minimum cost of this method of control,

A series of preliminary tests have been done on the mortality of late stages Chrysops larvae kept for two weeks in deep trays full of mud treated with different strengths of dieldrin. The trays were treated with emulsions containing 2.5, 0.75 and 0.075% dieldrin, at the rate of four pints per 100 square feet, but of these concentrations only the 2.5% emulsion produced more than a 50% larval mortality. Further tests are now being done on the same lines to assess the susceptibility of early instar larvae to dieldrin; and the fate of larvae in natural breeding sites sprayed at lower and less costly concentrations is now being investigated.

The survey of all potential Chrysops breeding sites around Kumba has now been completed in a thorough fashion and regular samplings of larval densities are being done at all sites. Simultaneously, catches of flies are being made around the perimeter of the station in order to assess the population density of adult flies in the area.

It is hoped that by 1960 sufficient information will have been obtained on the use of dieldrin as a Chrysops larvicide to warrant the initiation of a pilot control scheme at Kumba based on a sound scientific foundation.

TESTS WITH "RUELENE" AND "DELNAV" AGAINST MOSQUITOES

A. B. HADAWAY and F. BARLOW. Colonial Pesticides Research Unit, Porton. Report No. 170. Jan. 1960.

Tests were carried out with two organo-phosphorus compounds, "Ruelene", 4-tert-butyl-2-chlorophenyl methyl methyl-phosphoramidate, as 25% W.P. supplied by Dow Agrochemicals Ltd., and "Delnav" technical material supplied by the Hercules Powder Company Ltd., the major components of which are reported to be the cis and trans isomers of 2,3-p-dioxanedithiol S,S-bis(O,O-diethyl phosphorodithioate).

Test insects were 2-3 days old, blood-fed, female mosquitoes, *Anopheles stephensi.*

Results

"Ruelene": In contact toxicity tests, freshly sprayed deposits of the "Ruelene" wettable powder at a dosage of 100 mg per sq.ft. (= 1 g per m^2) on plywood panels were ineffective against adult mosquitoes. None of them died after resting in contact with the deposits for 2 hours.

Topical applications of a 0.5% solution of "Ruelene" (technical) in di-isobutyl ketone were made to the dorsal surface of the thorax of mosquitoes. No kills were obtained with dosages of 0.11 µg per mosquito.

"Delnav": Topical applications of a 0.5% solution of "Delnav" (technical) in di-isobutyl ketone were made to the dorsal surface of the thorax of mosquitoes. The following results were obtained:

Dosage µg "Delnav"/mosquito	Percentage kill	LD 50. µg "Delnav"/mosquito
0.112	93	0.083
0.090	60	
0.072	23	
0.054	3	

In comparison, the median lethal dose of malathion for *A. stephensi* is 0.005 µg per mosquito, and deposits of a malathion wettable powder at a dosage of 100 mg per sq.ft on plywood panels give 100% kills after a contact time of 15 minutes.

Conclusion

It is concluded that neither "Ruclene" nor "Delnav" is sufficiently toxic to A. stephensi to warrant further tests against adult mosquitoes.

TESTS WITH "BAYTEX" FORMULATIONS

Colonial Pesticides Research Unit, Porton. Report No. 171.
February, 1960.

This report deals with laboratory tests which were carried out with three 40% "Baytex" wettable powder formulations to provide information for the selection of the material to be used in further trials in the field at Arusha and in Nigeria.

The formulations tested were, "Bayer P 29580" (WHO/893), WHO/885 (a sample of material used in Greece by the W.H.O. Insecticide Testing Team in 1959) and WHO/897 (a Bayer experimental formulation).

Using female Anopheles stephensi as test insect, comparisons were made on plywood panels at a dosage of 25 mg "Baytex" per sq.ft. and on two types of mud bricks at a dosage of 100 mg "Baytex" per sq.ft.

In conclusion it is stated that "the experimental formulation, WHO/897, is less effective initially than the original Bayer wettable powder formulation P 29580 on both plywood and porous dried muds. In addition, the physical characteristics of WHO/897 are less attractive both because the powder is more difficult to wet out and because the suspension contains particles which might interfere with the spraying process.

Thus, P 29580 (WHO/893) remains the most effective "Baytex" formulation on many surfaces such as plywood which are relatively non-porous. So far, no formulation has proved effective on porous dried mud surfaces in the laboratory."

EAST AFRICAN TRYPANOSOMIASIS RESEARCH ORGANIZATION REPORT JANUARY-DECEMBER, 1958.

East Africa High Commission.

Use of Carbon Dioxide as an Attractant for Catching Tsetse.

Edney and Bursell (1955, personal communication) obtained what appeared to be an exceptionally large catch of *Glossina pallidipes* in a Morris trap after placing a quantity of solid carbon dioxide in it. Whether the flies were attracted by the CO_2 given off or by the lower temperature in the vicinity of the trap was not decided, though the former appeared more likely.

In an experiment at Lugala, (Busoga, Uganda), CO_2 from a 4-lb cylinder was passed in turn into one of a series of five Morris traps over 15 hours. The rate of flow of the gas was controlled through a flow meter at about two litres a minute (a convenient rate with the rather crude flow meter constructed) and the temperature in the traps was recorded at intervals. The total catch made over 15 hours by the trap with CO_2 was significantly greater ($P < 0.01 > 0.001$) than the catches without CO_2, but the recorded temperatures varied only slightly between traps depending obviously on their position relative to sun and wind. The experimental design allowed the variance between traps to be isolated from the variance due to CO_2, as the traps used were old and rather weathered. The precaution was shown to be justified by the occurrence of a significant difference between the catches made in individual traps ($P < 0.01 > 0.001$), which would otherwise have prejudiced the result. In the final analysis 14 NT (non-teneral) male and 84 NT female *G. pallidipes* were caught in a trap with CO_2 compared with 22 NT males and 96 females in the equivalent of four traps without.

As a fresh breeze was blowing during the experiment, the CO_2 must have disseminated very rapidly from the traps, suggesting that *G. pallidipes* may be sensitive to minute traces of the gas.

The method used was too laborious to be recommended as a regular practice when trapping tsetse, but it should not be difficult to devise easier methods of increasing catches with the aid of CO_2 which may yield more than a three-fold increase in numbers. Further experiments are planned to test the effects of other gases, and of solid carbon dioxide.

INTERNATIONAL SCIENTIFIC COMMITTEE FOR TRYPANOSOMIASIS RESEARCH
SEVENTH MEETING, BRUSSELS, 25-30 AUGUST, 1958.

Report of Section on Entomology

The Committee notes the valuable results that have been obtained on the identification of tsetse blood meals collected from both East and West Africa, and considers that this work should be greatly extended. It draws attention to the discrepancies observed between the food preferences thus indicated and the incidence of trypanosome infection found in the wild game and suggests that these differences require elucidation. It also recommends that research on food preferences should be linked with more detailed studies of the behaviour patterns of both Glossina and its host species in relation to their common habitats. The possibility of domestic cattle becoming an alternative host where game destruction is carried out, should not be ignored. The Committee again draws attention to Recommendation IV* of the sixth meeting and believes it would be valuable if selective game destruction experiments could be carried out.

The Committee notes that the criteria available for the identification of the species of trypanosomes in the tsetse fly are still far from satisfactory and regards it as important that this should be remedied. The Committee recommends that the estimation of challenge should be based on standardised criteria that should include the density activity of the tsetse present based on truly representative samples obtained by using cattle as bait, the infection rate of these tsetse and the reactions of a test herd of control cattle.

The Committee draws attention to the need for further studies designed to render more precise the observations on the location of Glossina in nature and notes the valuable results already achieved in the study of the day-time resting places of tsetse. It is also greatly impressed by the possibilities inherent in the use of glass bead paints for locating tsetse flies at rest at night.

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* Recommendation IV (6th Meeting) was: to utilise game killed in control operations to provide information on the incidence of trypanosomes on different species of the wild fauna; and to supplement the examination of blood films with other measures.

The Committee considered the question of fly advances and recessions and recognises this to be an extremely complex one. In view of the evidence that during the last few years extensive fly advances have taken place, it recommends that detailed studies be undertaken to elucidate the features which characterise them and the factors which cause them.

The Committee notes the successful use of discriminative clearing and insecticidal control, but considers that these measures could be made more efficient. Were our knowledge of the relation of the tsetse to its habitat more precise these measures could be applied with greater confidence in new situations. It therefore recommends that the ecological studies already noted as giving such good results in this direction should be intensified and extended as speedily as possible.

The Committee notes the success hitherto achieved in the rearing of tsetse flies under laboratory conditions and stresses the fundamental importance of this work, which should be intensified.

Researches on the Tsetse Fly

The following summary is prepared from reports of the Meeting given in Publication No. 41 published under the sponsorship of the C.C.T.A. (Commission for Technical Co-operation in Africa South of the Sahara).

Control and Eradication: An account of the "Broken Hill-Mulungushi Dam" Tsetse Eradication Scheme 1941-56 is presented by W. S. Steel and J. A. Gledhill (1). Insecticide trials, it is reported, "were carried out in the dry season of 1953 with a DDT residual formulation, and a BHC in dieseline formulation applied as a fog. A total of 1,900 gallons of DDT formulation consisting of 1,720 lb DDT 50% wettable powder in water was applied in three applications at monthly intervals, to selected parts of the concentration area between Kasamba and Nyankuru, in all about 1½ square miles. The reduction in the fly round catches as compared with the same months of the previous year was around 83% but the method was found to be a difficult one to operate, and there appeared to be no prospects of cutting down the cost which was £45 per square mile per application for insecticides only; in fact, results suggested that the rate would have to be increased.

The trials with fog application of BHC were made in the area around Mwana III, spraying at various times between evening and morning along parallel tracks at 100-yard intervals. A total of 783 gallons of BHC was applied in two applications over an area of about 2 square miles. Under the conditions prevailing, the best spraying time assessed visually was between 3 and 5 a.m. though at all times between 6 p.m. and 7 a.m. the blanket of fog drifted compactly, to well over the 100-yard intervals of the spraying traverses. Fly reduction immediately after fog application was 100% for the first application and 85% for the second. The flies caught after the second application, however, were on the edge of the spraying area and probably were migrants from outside foci. A commercial BHC formulation and one prepared on the spot were used for the purpose of comparison in this trial. Preparation on the spot was found to be quite practicable, whereas difficulty was experienced with the commercial preparation due to sedimentation.

Comparative costs were: commercial formulation £10. 10. 0. per 45-gallon drum; local preparation £7. 13. 3d. per 45-gallon drum. On the basis of the cheaper preparation the cost was approximately £33. 10. 0. per square mile per application for the insecticidal solution only. Working on the basis of length of gestation period of a newly emerged female, at the average existing temperature, it was established that applications would be required at eighteen to twenty-day intervals. There was also evidence that the distance between spraying transects could safely be increased. On the basis of these trials, preparations were made for full-scale fog application in 1954.

The first application was made from August 10th to 22nd with 2,135 gallons of insecticide over an area of about 19 square miles. About a quarter of the area was fogged at 150-yard intervals, and the rest under more favourable conditions at 300-yard intervals. Mechanical hold-ups and the fact that there was only one European available to operate the T.I.F.A. and conduct the fogging, lengthened the application period and restricted the area which could be covered. For the third, fourth and fifth applications, two European officers were available to conduct operations, and for the last two operations 25 square miles were covered. From the end of the fifth application no flies were caught on the regular fly rounds until the January 25th, when two males were caught near Bwawawa. That is, the fly concentration areas had remained free as far as could be judged, for two months after the end of fogging operations.

Operations at Chingola are reported by W. S. Steel, J. A. Gledhill and L. B. Norton. (2). The equipment and insecticides were as used for the Mulungushi spraying in 1954 - a Todd Insecticidal Fog Applicator mounted on a Land Rover trailer with two 45-gallon drums, one each bolted on to the vehicle and the trailer, a 1% gamma BHC solution formulated on the spot from 30% gamma technical BHC and dieseline, and a five-ton truck. In all, two hundred and forty drums or 10,800 gallons of the BHC formulation were applied, the discrepancy of seven drums being due to the fact that the T.I.F.A. did not pump out the whole of the forty-five gallons from each of the reservoir drums before they were refilled.

Total fly catches fell from seventy-eight in July 1955, immediately prior to the fogging, to one in December 1955, at its completion. By the end of December 1956, only one tsetse fly had been caught in six months, and it would appear that the drop-off from March was largely due to the inability of the tsetse population to maintain itself. Checks in the following dry season when an increase in the number of fly caught would be expected, did not catch a single fly.

A scheme designed to exterminate G.palpalis from about two hundred and fifty miles of the Kuja and Migori rivers and their tributaries, an area extending from the mouth of the Kuja river on Lake Victoria to Migori in the east and from the tributaries Angoche and Ondoiche on the Tanganyika border in the south, to the Kabwoch forest on the Upper Kuja in the north is described by P. E. Glover, J. G. Le Roux and D. F. Parker (3). The authors summarise the results so far achieved:

G.palpalis fuscipes Newstead has been exterminated from more than 300 miles of the Kuja and Migori river systems, an area in South Nyanza in which periodic epidemics of sleeping sickness have occurred. The operation described above began in 1955.

In the first phases of the operation conducted in 1955, a Shell Chemicals' product, "Arkotine S.D.18" (15% DDT) diluted with water to 5% was applied four times to paths cut on both banks of the rivers at fortnightly intervals by means of knapsack sprayers. From January 1956 onwards, however, "Dieldrex 15" (an 18% dieldrin emulsion) diluted to 1.8% with water, applied three times at three-weekly intervals, was used. Wherever re-infestation occurred, 5% "Dieldrex" was applied,

By October 1957 only three G.palpalis were caught along more than three hundred miles of river and by the end of June 1958 one further fly was taken in the area lying within the scope of the present scheme.

Costs, including staff salaries, labour and transport, have worked out at about £120 per river mile. The average cost of bush-clearing to provide protective barriers to re-infestation was £150 per mile, whilst that for insecticides (including cutting paths) averaged £60 per mile.

There was a spectacular reduction in the number of cases of human trypanosomiasis treated in 1955, with a further considerable drop in 1956 and a slight, but insignificant, rise again in 1957.

Bush Clearing: The felling of 80 acres of riverine fringe vegetation in the Rengwe Valley, S. Rhodesia, is described by R. Goodier (4). Complete elimination of the resident tsetse was achieved in the course of three to four months as against two to three years in similar trials in other parts of Africa, and provides interesting confirmation that ecological methods in the control of tsetse can be expected to have their greatest effect when applied to tsetse populations inhabiting country near to climatic limits of their distribution.

De Sousa (5) reported on the use of phytocides in Mozambique. Phytocides used were 2,4,5-T and a mixture of 2,4-D + 2,4,5-T in such solvents as diesel oil and paraffin.

Other Topics: These include: contributions on the host relationships of tsetse (6), (7), (8); feeding with regard to age factor (9) and probing (10); night observations on the fly (11); intensity of attack (12) and use of records (13). Accounts are given of the rearing, in the laboratory, of *G.palpalis* and *G.morsitans* respectively (14), (15). Other papers relate to *G.pallidipes* in S. Rhodesia (16), *G.morsitans* on transect fly rounds (17), *fusca* spp. in W. Africa (18), *G.morsitans submorsitans* in N. Nigeria (19), (20), and to new species in l'Ile du Prince, Gulf of Guinea, (21).

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THE DISPERSAL OF INSECTS - A THEORETICAL MODEL BASED UPON RANDOM MOVEMENT

D. YEO. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 249. Nov. 1959.

"When studies of longevity are made, the individual insects are tagged early in their lives, and subsequently recaptures are made over quite large areas. From these recaptures the proportion surviving to a known age may be deduced if, and only if, there is no emigration of individuals from the area that is searched, or if this emigration can be assessed quantitatively. Recently an examination was made of data collected with tagged mosquitoes, and it was difficult to interpret the results because the relative importance of emigration and mortality could not be estimated. It seems likely, however, that the searched area was too small, and it seemed worthwhile estimating the losses due to emigration on the basis that dispersal was random."

In the mathematical model it was assumed that the mosquitoes were all released at birth at a site in the centre of a circular searched area. Movement was assumed to be random. The problem is then analogous to that of the diffusion of a gas.

The mathematical theory is given and numerical calculations presented for a mean dispersal of 0.5 and 0.75 miles per day, and for a searched area of radii 0.5, 1, 2 and 4 miles.

In discussion the author points out that dispersal from a point may not be random in nature, but such an assumption probably approximates to the upper limit of dispersal, and gives useful data for planning the details of an experiment to study movement and longevity. From one of the equations it is evident that the mean range of dispersal is proportioned to $\sqrt{t}$ and this might be used to check the applicability of the assumption of randomness.

For a mean daily range of 0.75 miles it is evident that the searched area will have to be greater than 4 miles in radius if emigration is to be reduced to a low value. Even with an area 4 miles in radius, some 45% of the mosquitoes alive after 32 days will have moved outside the area, while for a radius of 1 mile the corresponding loss by emigration will be about 85%. Such losses would make it extremely difficult to assess mortality by counting the insects remaining in the area.

One figure shows how badly measured is the mean dispersal if the searched area is too small. For areas up to 1 mile in radius, and for a mean daily range of 0.75 miles, dispersal is effectively so rapid that little change is shown in the apparent mean dispersal for periods of 1 - 32 days. An area 4 miles in radius gives a good picture of the dispersal of the first day, but the apparent dispersal soon becomes appreciably less than the true value even for an area this large.

COMPARISON OF THE PERSISTENCE OF INSECTICIDE EMULSIONS AND DUSTS IN IRRIGATED SOIL.

E. T. MESMER. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 252.

"The larva of the "red cane beetle" (Cochliotis melolonthoides) is a serious pest of sugar-cane in Tanganyika. Effective chemical control of the larvae depends on the insecticide remaining in the soil for long periods. Experiments were therefore carried out to compare the persistence of several insecticides in irrigated soil.

Application and Sampling

Soil from the sugar plantations at Arusha Chini, a sodium-clay type of soil, was dried by exposure to the sun, sieved through a coarse sieve to remove stones and roots, and then ground to a fairly fine powder using a maize grinder. The soil was then mixed with the requisite amount of insecticide in a small motor-driven cement mixer.

Samples were taken from each batch of mixed soil to give the initial concentration of insecticide in the soil. Tin-plate cylinders, six inches long, three inches in diameter and open at each end, were sunk into the ground until the tops of the tins were level with the ground surface, and were then filled with the prepared soil. Twenty replicates of each of six treatments were laid out. Each treatment was divided into three groups of seven, seven and six replicates. One group from each treatment was planted randomly in each of three furrows. The furrows were irrigated with the equivalent of three inches of rain every three weeks. Wherever possible two sample tins from each treatment were taken on each sampling date. However, on some occasions, only one sample was taken, the waterlogged condition of the lower parts of the furrows preventing the collection of further tins.

Chemical Analysis

The sample tins were cut open and the middle four inches of soil taken for analysis. The soil was ground and mixed. A fifty gramme sample was extracted with light petroleum in a soxhlet extraction apparatus for eight hours. The insecticide content of the extract was then determined by the estimation of the total chlorine using a modified Stepanow method. The moisture content of the soil was determined by drying weighed amounts for three hours at 110°C.

Results

The results were calculated as parts per million of insecticide in the dry soil, and as a percentage loss from the original amount of insecticide present. The "total chlorine" method for the estimation of the chlorinated hydrocarbon type of insecticides is not a specific method for any of the insecticides used in this experiment. It does not take into account the possibility of the insecticides degenerating into non-insecticidal chlorine-containing compounds. An attempt was made to establish the presence of toxic materials in the last samples to be taken by a bio-assay using adult female mosquitoes. The results of this bio-assay are simply an indication that insecticides are still present in the samples and is in no way quantitative.

Conclusions

All the insecticides studied in this experiment show a definite loss from the soil over a period of 60 to 68 weeks. Aldrin, endrin and DDT behave in a similar manner, there being between 60% and 70% of the original insecticide still present after 68 weeks. BHC decreases more rapidly to between 10% to 20% of the original amount in the same length of time. In the two samples studied, aldrin and BHC, there does not appear to be any great difference between the persistence of a dust and an emulsion formulation. With the exception of that originally treated with BHC dust, all the soil samples at the end of the experiment were toxic to mosquitoes."

REVIEW

Toxicity of Pesticides *

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Perspective

Well-known poisons such as arsenic, lead, mercury, cyanide and nicotine have been used as pesticides for many years mainly in agriculture and food storage. Since 1945 many new compounds have been introduced for the purpose of killing a great variety of pests, and a steady stream of articles discussing in a general way the dangers that can accompany the use of these new pesticides has perhaps created a false impression of the scale upon which poisoning has occurred. SIMMONS and HAYES (1951) briefly reviewed the published figures on accidental poisoning and showed that the accident record from the new pesticides was no worse than that from the older materials and, when compared with other toxic hazards, accidents from pesticides were few. CONLEY (1958) shows that there has been no important change in the total deaths due to poisons in the U.S.A. in the 40 years from 1915. During this period the use of the newer pesticides has developed on a very large scale. In 1955 suicides slightly exceeded accidents from poisons, and pesticides were responsible for 6% and 5·4% respectively of deaths from these causes. As an occupational hazard for agricultural workers poisoning from pesticides makes an insignificant contribution. From 1951 to 1955 in Britain there was 1 death from pesticides among 140 deaths due to tractors, falls, the attacks of bulls and similar hazards, while only 0·2–0·7% of 25,000 accidents causing lost time were due to poisons (EDSON, 1957). METCALF (1957) points out that in California, where about 8 m. acres are treated annually with pesticides, these chemicals caused 5% of 14,000 disability work injuries. Of these cases over half were due to skin damage rather than general poisoning. In California in 1954 one insecticide, parathion, caused 85% of the cases of systemic poisoning attributed to pesticides. In one area of the U.S.A. pesticides had been blamed as a contributory cause of fungus infections, hay fever, asthma, sinusitis, gastro-intestinal upsets, dehydration, alkalosis, malnutrition, pneumonitis, cancer, poliomyelitis, arteriosclerosis, heart disease and insanity (HAYES, 1954). A careful survey of such an area where DDT had been extensively used for several years failed to show any evidence of changes in the incidence of disease judged by hospital records (FOWLER, 1953).

The persistent interest in possible health hazards from pesticides cannot be attributed to any obvious gross effects on the health of the communities in which they

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* *We are grateful to the Author, and to the Director of the Bureau of Hygiene and Tropical Diseases, Dr. Charles Wilcocks, for permission to reproduce this article from the Bulletin of Hygiene, 1959, 34, (12), 1205-1219.*

are used or upon large numbers of those who use them. This interest in the toxic hazards from pesticides appears to persist for a variety of general reasons such as:—

1. The development of many new materials often extremely efficient at killing pests which may range from those that are virtually non-toxic such as the selective herbicides to the very poisonous insecticide parathion. Useful simple classifications of common pesticides are given by EDSON (1955) and KLIMMER (1957–8), and some estimates of the lethal dose for man by DUBOIS (1958b).
2. A general increase in technology in agriculture with higher standards of production and quality has led to an ever greater use of increasing number of these materials. The demonstration that crippling human disease particularly in the less developed areas of the world may be eradicated or reduced by using pesticides has led to many entirely new applications of these effective materials.
3. Rising standards of occupational health demand that more attention be paid to the prevention of occupational poisoning.
4. The concern felt by many that the use of pesticides in agriculture may incidentally add "chemicals to food", and so add another threat to good health.

Occupational hygiene as it relates to agricultural or public health field operations is not yet a well-developed subject, but clearly it will eventually form the basis for a proper assessment of the real hazards offered by the application of pesticides.

This review will only consider selected topics and will be orientated towards the interests of those using pesticides in public health work rather than for agricultural operations. In many cases those working in the public health field may be called upon to use pesticides in areas more remote than farms and in communities where medical facilities are extremely limited. Attention will be paid to the information on how exposure occurs during the application of pesticides. Those pesticides that are either in widespread use or those that have been the cause of poisoning under some conditions will be considered. No attempt will be made to mention all the common pesticides. It should be remembered that many selective herbicides such as the chlorophenoxy acetic acids are very safe to use. Maleic hydrazide freed from the stigma of being a carcinogen (BARNES *et al.*, 1957) is virtually harmless. These and other non-toxic materials may find a use in public health work and are obviously to be preferred to toxic materials like DNOC or pentachlorophenol (see below) for controlling vegetation.

Exposure to Pesticides

Hazards from toxic chemicals in industry are assessed by discovering how the worker becomes exposed to them. This involves a study of the operations in which the chemicals are used, the quality and design of the equipment and the extent to which the workers' environment is contaminated. Obvious difficulties face anyone making similar studies of the operations in which pesticides are applied, but some useful information has been obtained.

Because most pesticides are applied as fine sprays or dusts in order to ensure their adequate distribution over crops or wall surfaces it has perhaps been reasonable to assume that the major route of entry of a toxic pesticide has been through the respiratory tract. On the basis of such an impression, gasproof, air-conditioned tractor cabs were used by one firm applying DNOC as a herbicide (HUNTER, 1950). Some of the earliest studies on exposure during the spraying of parathion centred on the measurement of the concentration in the air round sprays and dusting equipment used in orchards. (KAY *et al.*, 1952; BRAID, WINDISH & ROSS, 1955). The concentrations round the operators were mostly less than 1 μgm./litre. BATCHELOR & WALKER (1954) and BATCHELOR, WALKER & ELLIOTT (1956) carried out more detailed studies on the actual exposure of operators applying parathion and DNOC in orchards. They measured the amounts of pesticide falling on various parts of the body surface and the quantities held up on filters fitted to respirators. Their data demonstrated beyond question that in this type of operation it is the skin and not the respiratory tract that is most severely exposed to the pesticide during its application. With parathion only 0·06 mgm. was inhaled each hour while 55·8 mgm. fell on the exposed parts of the body during the same period. In normal working clothes these were the face, hands, forearms, neck and upper front of the chest. Exactly similar data were obtained when the contamination from DNOC applied in a similar operation was measured. The authors pointed out that an exposure to parathion of the magnitude they observed might have been expected to produce symptoms of poisoning if man were as sensitive to parathion as are laboratory animals. Although blood cholinesterase estimations were not made on these men they showed no symptoms of parathion poisoning. BATCHELOR & WALKER (1954) thought this might be due to several factors such as the prolonged duration of the exposure before a toxic dose level was acquired, giving time for detoxication. There would also be some removal by washing, which the men did several times during the day, and possibly more protection from clothing than the authors allowed in their calculations. In the case of the men applying DNOC blood levels up to 10 μgm./ml. were observed (BATCHELOR, WALKER & ELLIOTT, 1956).

BORDAS *et al.* (1958) found concentrations of 0·5–1·35 mgm./m.^{3} of methyl parathion and malathion in the atmosphere during orchard and beet spraying. In Rumania, WASSERMANN and his colleagues (1959a) have found atmospheric levels around 1 mgm./m.^{3} in orchards during winter spraying with DNOC and similar levels for DDT and BHC in forest spraying (WASSERMANN *et al.*, 1959b). On the other hand the DNOC falling on the body of the orchard workers was equivalent to a dose of 6·6 mgm./kgm. in an 8-hour day.

A study of the hazards from tractor-driven sprays putting up the comparatively non-toxic insecticides has been made by CULVER, CAPLAN and BATCHELOR (1956). The average air concentration round the jeep driver was 2–4 mgm./m.^{3} and 0·5 mgm./m.^{3} 10–25 yards from the spray boom. The authors calculate that in 4 weeks at 40 hours' work per week the *total* intake by the respiratory route would be 5–11 mgm./kgm., while during the same period 17–45 mgm./kgm., would be deposited on the skin of the operators.

There seems no doubt at all that the skin is the main site of contamination by pesticides during a variety of outdoor application techniques and it must therefore be considered to be the main portal of entry of a pesticide into the body of the operator.

Indoor applications of pesticides have also been studied. In horticulture it is usual to put up pesticides in greenhouses as fumes, smokes or fine aerosols. Either full protective clothing with respirators is worn during the application (Culver, Kinosian, Thielen and Graul, 1958) or the operator leaves the greenhouse in front of the cloud he is putting up (Hughes & Read, 1959). Both these groups of investigators found that workers handling the treated plants in the greenhouse got a little pesticide on the skin but in quantities that could not be considered harmful. Why the workers studied by Culver *et al.* (1958) showed some fall in blood cholinesterase was not ascertained. Methyl demeton sprayed in a greenhouse did not raise the atmospheric level above 3·5 mgm./m.^{3} (Klimmer & Pfaff, 1958). Much public health work with insecticides involves indoor spraying to put deposits on walls. The preparations are usually water suspensions of wettable powders. Despite the closed environment, measurements by Wolfe, Walker, Elliott and Durham (1959) during the application of a typical DDT wettable powder show that while only 7·1 mgm. per hour of spraying was inhaled, 1755 mgm. fell in the same period on the skin of the face, head, neck, arms and hands. A man spraying 4 hours out of an 8-hour day in an open-neck, short-sleeve shirt without hat or gloves would receive a dose of 105 mgm./kgm. on his skin. The spray pressure, type of surface and temperature also had some effect on the amount of spray deposited on the operator. While most of those who apply pesticides will distribute the diluted material some will have to handle the concentrates and these must obviously present a much greater potential hazard to the careless worker. Sumerford *et al.* (1953) demonstrated this in a study of different groups of people connected with the commercial spraying of orchards with parathion. Only among the mixing plant personnel was there evidence of undue exposure represented by a significant fall in cholinesterase levels (see below) of the group during the spraying season. Full-time and part-time applicators were not so affected. Petty *et al.* (1959) found no fall even in mixers using parathion and methyl parathion in Louisiana. The danger from concentrates is illustrated by experience with DNOC. The 8 fatal cases of poisoning in Britain were in men handling 50% DNOC diluted to 0·5–0·8% for application (Bidstrup & Payne, 1951). American orchard workers used a 19% concentrate diluted to 0·02% and no evidence of intoxication appeared (Batchelor, Walker & Elliott, 1956). In locust control work 20% DNOC in oil is sprayed. Rainey (1958), summarizing experience with 70,000 gallons of this DNOC solution applied by aircraft, notes that a blood level exceeding 20 μgm./ml. was only observed in 19 of 234 tests and of these 15 were in staff loading the aircraft. The others were aircraft cleaners and truck drivers. Rainey also records that a highly concentrated (85%) diazinon preparation used against locusts was safely handled in field trials with only one instance of a possible slight depression of blood cholinesterase.

Aircraft spraying presents special hazards to the flying crew. The need for properly designed equipment has been stressed (Ingram, 1951). A special type of hazard for the pilot has been indicated by Upholt *et al.* (1956) who point out that a splash in *one* eye by an anticholinesterase insecticide which has a direct miotic effect (*e.g.* TEPP) may produce more serious difficulties in judging distances than a bilateral miosis. The contamination of those on the ground during aerial spraying has been measured by Caplan, Culver and Thielen (1956) when malathion was being used for outdoor mosquito control. Discharged at the rate of 0·46 lb per acre from a height of 70 ft. the atmospheric concentration was less than 0·1 mgm./m.^{3} outdoors or in buildings in the area. Total exposure of a man working outdoors during the spraying amounted to 3·5 mgm. while he inhaled less than 0·2 mgm. The observations mean that materials of a toxicity considerably greater than malathion could be safely applied this way over inhabited areas for insect control.

The health of those living in areas of intensive air and ground application of pesticides in orchards and cotton fields has been carefully assessed and no evidence found that such people have undergone any significant exposure to the pesticides being used (Sumerford *et al.*, 1953; Fowler, 1953; Quinby, Walker & Durham, 1958; Hayes, Dixon, Batchelor & Upholt, 1957). The inhabitants of houses treated with insecticides might theoretically be exposed to the active ingredient emanating from the sprayed surfaces. Most treatments of this type are designed for long-term effects so that loss by vaporization must inevitably be small. Malina, Kearny & Polen (1959) analysed the air in houses treated for termite control with chlordane. Using a technique able to measure down to 0·005 p.p.m. they only found chlordane twice in 12 analyses and each was below 0·05 p.p.m. The hazards from contact with sprayed crops may be more serious. Parathion has been responsible for a number of outbreaks of mild poisoning among those picking, cultivating, thinning or respraying treated crops (Quinby & Lemmon, 1958). The authors concluded that the parathion had been picked up on the skin and the inhalation of vapour in dense vines, for example, was not likely to be the source of the intoxication.

Protection

The evidence just summarized clearly points the way to the correct methods for the adequate protection of those applying pesticides. Gases, volatile materials or fine aerosols used in closed atmospheres obviously demand the use of a suitable respirator. However, under the conditions in which by far the greatest quantities of pesticides are applied in agriculture or public health work it is the skin that must be protected. In mixing and dilution of concentrates the hands are most exposed so that rubber gloves should be worn. Though the protection they give may not be absolute since some of the solvents such as xylene used in the concentrates can penetrate rubber, the speed with which splashes of a concentrate of a moderately toxic material like chlordane can produce fatal poisoning (Derbes, Dent, Forrest & Johnson, 1955) indicate the need for protection of the hands. Carelessly used, even the heaviest gloves will give only limited protection because the insides readily become contaminated if the technique of removing and replacing gloves during work is not good (Culver, Caplan & Batchelor, 1956).

The possibility of safer formulations to reduce the hazards from concentrates has been discussed by Hayes and Pearce (1953), and Deichmann, Brown & Downing (1952) claimed that the penetration of the skin by one insecticide was reduced by using a special emulsifier in the concentrates. Although possibilities may exist of increasing safety by modifying formulation it is the exact composition of the latter which will determine the adhesion, spreading capacity, phytotoxicity and price of the preparation hence its value as a pesticide.

Cotton clothing affords an adequate protection for the skin against wettable powder, as shown by Wolfe *et al.* (1959) in their study of 5% DDT sprayed indoors. Fletcher, Press & Wilson (1959), using similar experimental techniques, found that 0·5% dieldrin applied in a malaria control programme contaminated the men to the extent that they received a dose of 1·8 mgm./kgm. each day. The unprotected DDT spraymen received over 105 mgm./kgm. Regular washing of cotton protective clothing is recommended. Though soap and water failed to remove all of an insoluble material like dieldrin, Fletcher *et al.* (1959) showed that no transfer to the skin followed the wearing of such washed clothes. Nevertheless they recommended an occasional wash in petrol, which dissolves most of these materials. The WHO Study Group on Toxic Hazards of Pesticides to Man (1957) outline the protection needed by those applying pesticides indoors and emphasize the need for protection of the head and shoulders. Wolfe *et al.* (1959) have given details of the design of suitable protection for the head, shoulders and face. A visor of some transparent material will protect the skin of the face but is liable to become opaque from the spray deposited on it. Wolfe and his colleagues found that a plastic gauze (20 x 20 mesh) allowed good visibility, afforded adequate protection from droplets, did not get occluded and was comfortable to wear. Protection is only likely to be effective if the organisation of those applying a toxic material is satisfactory. Fletcher *et al.* (1959) describe how dieldrin has been safely applied and give full details of the operations of their team. Unfortunately similar studies are not available on workers in teams where poisoning has taken place.

Summaries of the safe handling of pesticides have been given by many people. Edson (1956) summarizes some 20 important points and includes an outline of the Poisonous Substances Regulations as they apply to agriculture in the United Kingdom. Cook (1956) in another review refers to such points as the hazards of casually transporting drums of concentrate in ordinary automobiles, and this is also referred to by Ashdown, Dahms, Ridgway and Stiles (1952).

Individual Insecticides

DDT

For a material with such a considerable biological activity which has been used on a wide scale with virtually no safety precautions for 15 years, DDT has a remarkable record of harmlessness. No authentic case of occupational poisoning by DDT has been recorded even among the workers in public health programmes where contact has been most extensive, most prolonged and probably most intimate. This record should be borne in mind by anyone considering the replacement of DDT by insecticides about which less is known or experience has been less fortunate. There is a large literature on DDT but it is not yet possible to say just where it exerts its poisonous action in the mammalian body or with what biochemical or physiological mechanisms it interferes. The whole subject has recently been most comprehensively reviewed by Hayes (1959b) in several fully documented chapters. It will suffice here to take a few points only and discuss them briefly. A comparison between the action of DDT on mammals and insects has been given and the many points of similarity underlined (Winteringham & Barnes, 1955). DDT is safe to handle because it only penetrates mammalian skin with great difficulty, it acts slowly and its poisonous effects are fully reversible. No pathological lesions have been described except moderate liver cell injury when lethal doses have been given to animals. Human poisoning by DDT has been described by several authors (*e.g.* Garrett, 1947; Hsieh, 1954) and has always been the result of ingestion of DDT usually finding its way accidentally into food. The description of several episodes gives a distinctive and consistent picture. Early nausea and vomiting are usual. Headache, weakness, dizziness, numbness, paraesthesia, incoordination and tremor come on within a few hours and may persist for several days but recovery is complete. The toxic dose for man by mouth is around 10–20 mgm./kgm. (the LD50 for animals is about 250 mgm./kgm.) but a man has survived a dose of 285 mgm./kgm. (Garrett, 1947). An interesting case is reported by Onifer and Whisnant (1957) of a butcher who had a vaporizer working continuously in a poorly ventilated room in which he spent most of the day. The vaporizer was charged with DDT and BHC and was not thermostatically controlled. Paraesthesia, tremors, fatigue and unsteadiness resembling the signs of DDT poisoning were observed. The symptoms cleared up completely when the man was removed from further exposure. Although this man probably only received a comparatively small dose of DDT he almost certainly received it by inhalation and not from skin contact. What part, if any, the simultaneous exposure to BHC may have played is not known.

The literature is scatterd with accounts of cases said to be the result of poisoning by DDT. Such accounts have been adequately criticised by Hayes (1959b). It would perhaps not be unfair to say that all these accounts have one or more of the following features:—

(a) The poisonous effects consist of a well-known clinical syndrome for which, among any group of hospital patients, it is often impossible to give a cause, *e.g.* peripheral neuritis, agranulocytosis, purpura.

(b) There is a complete absence of any of the authentic symptoms and signs of DDT poisoning so well described in the papers referred to above.

(c) A complete diversity of the clinical pictures of the various cases recorded.

(d) The victim has often had an absolutely minimal exposure to DDT, either at work or from its use in the home.

(e) There has been a failure to consider critically the features of the illness and the possibility of other causes.

(f) The authors lack any first-hand knowledge of DDT as a poison for man or in the laboratory. This is often evident from their ignorance of the literature or their highly selective and ill-balanced assessments of previous observations.

Unfortunately, inaccurate and inadequate accounts tend to be referred to again and again by successive authors. As Heyroth (1952) pointed out in discussing the report of a doubtful case of insecticidal poisoning, care should be taken to see that titles of papers do not have " a degree of finality not apparent in the authors' own comments."

If DDT is capable of causing human illness other than specific poisoning, those in charge of malaria spray teams are the people who will detect these cases for they are in touch with the most exposed groups of workers. A careful study of 40 men exposed for $\frac{1}{2}$–8 years, in DDT formulating plants where no protective clothing was worn, revealed no evidence of disease attributable to the exposure nor did there appear to be any unusual rate of turn-over of workers in these particular factories (Ortelee, 1958). Controlled administration of DDT to volunteers in doses of 3·5 mgm. and 35 mgm. per man per day produced no symptoms even when dosing was continued for 18 months. The level of DDT in the fat rose to over 200 p.p.m. in the men on the highest dose (Hayes, Durham & Cueto, 1956). This compares with the average level of 4·9 p.p.m. in the general population of the United States. The DDT in those not occupationally exposed comes from food—mainly fat of animal origin (Hayes, Quinby, Walker, Elliott and Upholt, 1958). No account of alleged DDT poisoning has yet been accompanied by a figure for the DDT level in the fat.

There is no simple clinical or biochemical test that can be used to detect exposure to and absorption of DDT. Biopsy and the analysis of body fat for DDT is not a practical procedure. On the other hand the estimation of the main metabolite of DDT, namely DDA (dichloro-di-phenyl acetic acid) in the urine is feasible in a good laboratory and reflects the uptake of DDT (Hayes, Durham & Cueto, 1956). However, in the absence of any evidence of illness that can be attributed to exposure to DDT there is no incentive to organise tests of this kind on workers who use this insecticide. A number of compounds chemically related to DDT are effective insecticides though less widely used.

Methoxychlor

Methoxychlor is virtually non toxic to mammals by mouth or when applied to the skin, though by intravenous injection it is as toxic as DDT (personal observation). It is metabolized very rapidly by the liver and the breakdown products appear in the bile of rats (Weikel, 1956, 1957).

DDD

DDD is also almost non-toxic to mammals but it has an unusual effect on dogs, causing an atrophy of their adrenal cortex (Nelson & Woodard, 1949). Attempts to use DDD for the therapeutic reduction of adrenal cortical activity have been unsuccessful (Sheehan, Summers & Nichols, 1953; Zimmermann *et al.*, 1956), indicating that man, like the rat, is not sensitive to this action of DDD (Stoner, 1953).

BHC

The original preparation contained the alpha, beta, gamma and delta isomers of which the gamma isomer is insecticidally active and is now available alone as lindane. Lindane is a little more toxic than BHC probably because in the mixed isomers the sedative effects of the beta and delta isomers counteract the convulsive action of the gamma isomer. Like DDT, BHC has an excellent record of widespread use without evidence of occupational poisoning. There is a single record of a woman who had a fit the day after helping her husband to spray calves and cattle; some of the calves died (Herberg & Wright, 1955). Accidental poisoning has occurred under a variety of circumstances including the administration of BHC as a vermifuge. Graeve and Herrnring (1949) describe one man who felt ill and another who had a fit after 45 mgm. BHC. Klosa (1950) on the other hand recorded only mild symptoms such as burning of the tongue after 40 mgm. daily for 10 days. Increasing the dose to 90 mgm. produced only mild symptoms. Schmiedeberg and Wasserburger (1953) recorded fits and loss of consciousness in a man taking 1,000 mgm. Recovery in these and other episodes of acute poisoning was rapid, which is consistent with the evidence that BHC is rapidly metabolized (Asperen and Oppenoorth, 1954). Other cases of poisoning have arisen from the misuse of BHC powder to control parasites and domestic pests. Danopoulos, Melissinos and Katsas (1953) recorded 79 such cases with 6 deaths. The signs of poisoning—prolonged in some cases—were lassitude, spasms, paresis, ataxia, tremor and mental confusion. Probably because of its widespread use rather like DDT, BHC has been debited with a number of illnesses the reports of which bear all the characteristics of those recorded above for cases of alleged DDT poisoning. Clinical tests for exposure to BHC are not described. As with DDT there is no incentive to explore possibilities. Phenobarbitone will control convulsions (Buck, Pfannemüller, 1957; Nicholls, 1958).

Dieldrin and Related Insecticides

Aldrin, dieldrin, endrin and isodrin are four closely related chlorinated methano-naphthalenes very active as insecticides. Their chemical structure is clearly depicted in the paper of Treon and Cleveland (1955). Dieldrin has been responsible for a great many cases of poisoning among those applying it in public health programmes in many different parts of the world (Hayes, 1957). Aldrin, dieldrin and endrin have also been used extensively in agriculture but there are no reports of poisoning during their use on crops. There is one account of men poisoned by aldrin in a formulating plant (Nelson, 1953). As aldrin appears to be oxidized to dieldrin within the animal body (Bann, DeCino, Earle & Sun, 1956) and poisoning by endrin (Davies & Lewis, 1956) seems to be very similar to that produced by dieldrin, it will be convenient to discuss dieldrin as a type substance in this group. Chlordane is chemically related to dieldrin and though less toxic its action is similar (Stohlman, Thorp & Smith, 1950; Ambrose *et al.*, 1953). It has had a limited use in public health work and more considerable use in agriculture. Occupational poisoning has not been described but accidental-poisoning has occurred (see below).

Dieldrin as an acute poison has a violent convulsive action in all species studied (Treon & Cleveland, 1955). Pharmacological studies have confirmed that the threshold for central reflexes is decreased and the effects on cats and rabbits are counteracted by barbiturates (Gowdey *et al.*, 1954). However, there is little support from other evidence for the views of these authors that the action of dieldrin is similar to that of eserine and possibly related to an effect on cholinesterase. Although there may be points of resemblance between the action of DDT (Bromiley & Bard, 1949) and dieldrin on the decerebrate cat there is little if any similarity between their action as poisons in man. Considering its widespread use and interest as a toxic material, it is surprising how little experimental work has been reported on dieldrin and related compounds. The literature is fragmentary compared with that on the organo-phosphorus compounds. Nothing is known of its metabolism except that there is some tendency for dieldrin to be stored in fat (Bann *et al*, 1956). No suggestion can be made for any biochemical basis for the toxic effects produced by dieldrin. On one important point the laboratory study of the toxicity of dieldrin does help to explain the features of dieldrin poisoning described later. Dieldrin, whether applied as a powder or in a solvent, penetrates the skin of animals very readily so that the toxic dose by repeated application to the skin is very similar to that for dieldrin given by mouth (Treon & Cleveland, 1955; Hayes, Ferguson & Cass, 1951). As discussed in an earlier part of this review, the skin appears to be the main site of contamination for a man applying pesticides under the usual conditions either indoors or outdoors. DDT and BHC have been applied safely for years in malaria control work. The toxic dose of DDT or BHC when applied to the skin of animals is 2 or more grammes per kgm. whereas dieldrin can kill rats and rabbits at less than 300 mgm./kgm. (Hayes, Ferguson & Cass, 1951; Treon & Cleveland, 1955). It is utterly misleading to claim that "the fact that aldrin and dieldrin are innately more toxic to animals than DDT need not be of concern . . . because (they) have a very high toxicity to insects and consequently they are generally applied at only a fraction of the dosage or concentration at which DDT is normally used" (*Shell Technical Bulletin* ADB 421/Da 10). Such a view disregards the fact that the original concentrated preparation may well be the same though it may be diluted more before application. As noted earlier it is the manipulation of the concentrated pesticides that is often the hazardous part of the operation of applying pesticides. Such a view also ignores any differences there may be in the toxic properties of two pesticides such as the readiness with which they penetrate the skin.

Dieldrin has been used safely for many agricultural purposes but wherever it has been extensively used for spraying houses in insect vector control programmes poisoning has occurred (Hayes, 1959a). On a small scale well trained operators have applied dieldrin safely for this purpose (Fletcher, Press & Wilson, 1959). These authors discuss the reasons for their safety record when compared with the less fortunate experience of others. The concentration of dieldrin sprayed was low (1·1–0·55%) compared with the concentration of 1·25–2·5% sprayed in areas where casualties occurred. The hours of work were shorter than in Venezuela and the standards of hygiene were higher than in most other areas. However, Hayes (1959a) points out that the numbers exposed in the spraying operations described by Fletcher *et al.* (1959) are very small compared, for example, to those at risk in Venezuela so that an incidence of poisoning of, say, 10% could not have produced casualties in the group studies by Fletcher *et al.*, purely by chance.

An accessible first-hand account of dieldrin poisoning is that of Patel & Rao (1958) but the most detailed reports of the largest number of cases come from Venezuela (Blázquez & Bianchini, 1956; 1957a,b; Carrillo, 1956; Winthrop & Felice, 1957). Blázquez & Bianchini, (1957a) describe 3 stages of intoxication among the spraymen:—

(1) Headache, blurred vision and incoordination.
(2) Myoclonic spasms and falls sometimes without loss of consciousness.
(3) Epileptiform attacks.

The spasms and fits may come on unexpectedly either during work or at any other time, either when active or even in bed at night (Patel & Rao, 1958). There is no "aura" and apart from headache and blurring of vision in some cases there may be no preceding symptoms of sufficient severity to have caused the poisoned man to complain. However, Winthrop & Felice (1957) showed that in men who were spraying dieldrin and examined carefully, compared with men not exposed to dieldrin, there was increased frequency of such symptoms as: headache, blurred vision, vertigo, dizziness, disturbance of sleep and muscle twitching. The signs of poisoning are consistent with what is known of the pharmacological action of dieldrin. No deaths have been recorded in the literature from dieldrin poisoning though Hayes (1957) refers to a single fatal case in a sprayman. Nor have persistent neurological sequelae—paralysis, ataxia, tremors etc.—been described in any of the recorded cases of poisoning.

Clinically, dieldrin poisoning has two features not readily explained on existing knowledge of its toxic properties. A long period of exposure is usual before the symptoms of acute dieldrin poisoning appear in spraymen. Patel and Rao (1958) had one case after only 60 days of contact, but in Venezuela Blázquez and Bianchini (1957a) found 4 months to be the minimum exposure period before poisoning appeared. Patel and Rao (1958) suggest that this may be evidence of the development of some form of hypersensitivity to dieldrin but there is no confirmatory evidence yet available for such an explanation of this delayed response. Again, the first signs of poisoning may appear after exposure has ceased, or recur up to 100 days after removal of the patient from working with dieldrin (Hayes, 1957). Further experimental work is needed to provide an explanation for these observations. The late recurrence of symptoms makes it impossible to recommend a safe period after which a poisoned individual may resume work with dieldrin (HAYES, 1957).

There are no tests available which will detect or measure the absorption of dieldrin and so provide warning of dangerous exposure. CARRILLO and BLÁZQUEZ (1955) described a test in which *Rhodnius* larvae were fed on dogs that had been dosed with dieldrin; the subsequent death of the larvae indicated the presence of dieldrin in the blood. This test has been recommended as an aid to diagnosis of suspected dieldrin intoxication in man (BLÁZQUEZ & BIANCHINI, 1957b). WINTHROP and FELICE (1957) found that direct blood dieldrin estimations were no value in determining whether or not exposure had taken place.

Barbiturates are effective in treating the convulsions in dieldrin poisoning in man (BLÁZQUEZ & BIANCHINI, 1957a) as they are in aldrin poisoning (SPIOTTA, 1951).

Prevention of poisoning must lie in adequate training to avoid gross over-exposure such as will occur if dieldrin powder is carried in the bare hands (PATEL & RAO, 1958). The workers in Venezuela abandoned the precautions suggested because they did not believe the poisoning would occur—"it had never happened with DDT" (CARRILLO, 1956). It is not reasonable to expect spraymen automatically to accept the fact that dieldrin is different from DDT; they must be educated to handle it carefully (*WHO Technical Report* Ser. No. 114). WINTHROP and FELICE (1957) recommend protective measures that would undoubtedly make it safe to apply dieldrin or indeed almost anything, but experience seems to show that hard work in hot climates will not be done in full protective clothing. WOLFE *et al.* (1959) have illustrated how the exposure of the face, head and shoulders may be simply controlled for indoor spraying. If facilities for good general hygiene—washing of both the sprayman and his clothes—are not available it is not safe to use dieldrin (HAYES, 1959a). It is not really possible to name any one factor as being responsible for dieldrin poisoning among spraymen. As HAYES (1959a) points out, the men inevitably become contaminated during application; even under the best conditions FLETCHER, PRESS and WILSON (1959) found that the men received a dose of 1·8 mgm./kgm. per day when using the most dilute spray (0·55%) of any employed in these operations. Stronger spray solutions, different spraying equipment, less skin protection, poor washing facilities and a generally careless technique, with longer hours of work over a more continuous period, will all add something to the risks.

It is not within the province of this review to discuss the relative merits of dieldrin, DDT and BHC as insecticides for mosquito control. Some pertinent information has been given by BURNETT (1957) from which it appears that dieldrin may have limited advantages under special conditions, for example where eradication is the aim. Whether or not the results of using dieldrin can justify the exposure of those who apply it to risks of an unpleasant and perhaps rather protracted, but not fatal, form of poisoning must be assessed by those responsible for recommending its use.

Organo-phosphorus insecticides

The best known insecticide in this group is parathion which was one of the earliest to be exploited and remains popular because it is effective and relatively cheap. Parathion has probably caused more accidents of all types than all other modern insecticides. The early development of parathion, coupled with the fact that the highly toxic potential war gases—sarin and tabun—are of the same family of toxic compounds has perhaps tended to overshadow the development of organo-phosphorus insecticides of very much lower mammalian toxicity. Malathion, for example, must rank among the least toxic pesticide of any type and there is an increasing number of organo-phosphorus insecticides of intermediate toxicity. It is impossible to discuss or even mention all the organo-phosphorus insecticides which have been developed and used. The review will be limited to parathion, diazinon and malathion, representing the severely toxic, moderately toxic and very mildly toxic groups of these insecticides. All have a potential or actual use in public health work. In considering other organo-phosphorus insecticides compounds it is possible to classify them into one of these three groups on the basis of their toxicity to mammals. In use they can then be treated accordingly.

Parathion has been widely used all over the world and from everywhere have come reports of poisoning—occupational, accidental, suicidal and homicidal. These reports are too numerous to list. In Japan, NAMBA and HIRAKI (1958) report that thousands of cases of poisoning have occurred but that at the same time the rice crop has been significantly improved by the use of parathion; most of the casualties in Japan are among the farmers. PRIBILLA (1955) in a very comprehensive review gives details of 34 fatal cases, mostly in Europe, of which only 7 were occupational.

Accidental deaths unconnected with the proper use of parathion will be considered later. MICHAUX, THIODET and DEYME (1954), RODIER (1955) and DELONS (1958) give accounts of occupational poisoning with some fatalities typical of those which occur when parathion is introduced into communities not properly adapted for the safe handling of dangerous pesticides. RATHUS and BOTTOMLEY (1958) and GILSENAN (1957) give accounts of typical types of carelessness leading to death in users of parathion who should have known better.

Although it is so toxic, parathion has been and continues to be widely used in safety by those who respect its potential dangers. In some cases little protective clothing is worn because of the heat, but good general hygiene will prevent poisoning from the inevitable skin contamination discussed above. In public health work parathion is valuable for indoor use for killing flies resistant to DDT and related insecticides. KILPATRICK and SCHOOF (1956) have described the efficacy of cotton cords soaked in parathion solution and suspended in rooms for controlling flies, and GLÖMME and SWENSSON (1958) have demonstrated the safety of such preparations in that they do not significantly contaminate the atmosphere. Parathion has been sprayed in large barrack rooms without the use of respirators (STEINIGER, 1951) for the control of bugs, but it has been pointed out that the hazards facing those who made such occasional applications cannot be compared with those facing teams having to carry out such continued applications as would be needed were parathion to be used in work such as malaria control (*WHO Technical Report Ser.* No. 114, 1956).

Methyl parathion has been widely used in some areas in place of parathion (Petty *et al.*, 1959). Although it is somewhat less toxic than parathion to mammals, Deichmann, Pugliese and Cassidy (1952) rightly emphasize that "this compound and its formulations still represent highly toxic preparations". One possible safety factor in considering any di-methoxy phosphate *vis-à-vis* its di-ethoxy analogue is that cholinesterase inhibited by the dimethoxy compound is more rapidly reversed by natural hydrolysis (Aldridge & Davison, 1953); *persistent* exposure of cholinesterase to a dimethoxy inhibitor, however, will more readily lead to a truly irreversible inhibition (Aldridge, 1957). At this stage inhibited cholinesterase is not amenable to the action of reversing agents (Hobbiger, 1956).

Diazinon is an organo-phosphorus insecticide of intermediate toxicity to mammals (Bruce, Howard & Elsea, 1955) and, to judge from the report of a single unsuccessful attempt at suicide, also less toxic to man (Bockel, 1957). It has been widely used in public health work for the control of flies resistant to the action of DDT, and in some countries it has been sold for domestic use for the same purpose. Diazinon has also been used in agriculture. Serious cases of occupational poisoning have not been reported. Floris and Cossu (1955) reported 2 mild cases of poisoning among 20 men applying diazinon for fly and mosquito control. During a month of work all the men showed some fall in blood cholinesterase levels more or less proportional to the duration of their exposure. The men were reported to have worked in overalls, rubber boots and gloves and respirators. Mosna and Alessandrini (1954) reported falls in blood cholinesterase in workers who did not wear respirators when applying diazinon indoors. They concluded that diazinon could be safely used for indoor spraying if full precautions were observed. Whether or not the respiratory route is the most important in the case of diazinon spraying would need further evidence. Bruaux (1957) reported observations on 36 men spraying diazinon out of doors for fly control 5 days a week all the year round for 2 years in the tropics. Falls in blood cholinesterase were noted and some were as low as 20% of normal values, but no symptoms of poisoning were reported and low levels returned to above normal within 1½ months of removing the men from exposure. Rainey (1958) records the safe use in field trials of a highly concentrated (85%) diazinon preparation sprayed from aircraft to kill locust swarms.

Malathion, though an efficient insecticide is, under ordinary circumstances, of extremely low toxicity to mammals (Hazleton & Holland, 1953); a dose of 1–2 gm./kgm. is needed to kill rats and dogs. In man there have been reports of a 34-month-old baby (Goldman & Teitel, 1958), and a woman aged 35 (Walters, 1957) who survived and rapidly recovered from a dose of malathion taken by mouth, which was great enough to cause an initial loss of consciousness. However, malathion must not be regarded as being completely harmless. A mysterious illness in a 10-year-old child the day after a picnic was finally traced to the fact that "fly flakes" a preparation based on malathion, had been liberally scattered round a hut where the children played and ran barefoot. The flakes were still in the child's clothes next day. She rapidly recovered when the malathion contamination was removed (Parker & Chattin, 1955). The comparative non-toxicity of malathion for mammals is probably related to the speed with which part of the molecule is hydrolysed in the liver (O'Brien, 1957). However, this detoxication mechanism may be upset by other esterase inhibitors which include some *but not all* of the other organo-phosphorus insecticides (Frawley *et al.*, 1957; Cook, Blake & Williams, 1957; Dubois, 1958a). The significance for men of the potentiation of the toxicity of malathion by other organo-phosphates cannot yet be assessed but the possibilities of some risk should be considered if mixtures of organo-phosphates are used.

The safety for urban inhabitants of aeroplane application of malathion sprays has been demonstrated (Caplan, Culver & Thielen, 1956 see above) and Golz (1959) has shown that 84 exposures to malathion domestic aerosol in 42 days produced no lowering of blood cholinesterase in 10 subjects. This indicates that such preparations are safe at least as far as their insecticide content is concerned. Bruaux (1957) used malathion for outdoor spraying in fly control and during a year's experience of continual use found no reduction of serum cholinesterase but a slight reduction in the red cell enzyme.

Control of hazards from organo-phosphorus insecticides

All these insecticides probably owe their toxic action to the accumulation of acetylcholine in the tissues which follows the inhibition of the enzyme cholinesterase which is normally present at the sites where acetylcholine is liberated. In many cases death is due to paralysis of the respiratory centre (de Candole *et al.*, 1953) probably coupled with inefficient functioning of the respiratory muscles. Some very toxic organo-phosphorus compounds (Heath & Vandekar, 1957) do not penetrate to the brain so that the latter mechanism alone, or other mechanisms, may sometimes be responsible for death.

It has long been recognized that the earliest evidence of exposure to an organo-phosphorus insecticide may be obtained by measuring levels of activity of blood cholinesterase. Significant falls of activity may be observed before any symptoms have appeared and when this happens poisoning may be prevented by withdrawing the exposed people from further contact or tightening up the precautionary measures for their protection. The widespread use of blood cholinesterase determinations, and the demand for methods that can be used, literally, in the field have resulted in the transformation of what was once a procedure used by the experimental biochemist to a simple, if less accurate, manoeuvre for the technician working, if necessary, in the open air. A detailed account of the electrometric method (Michel, 1949), the cholorimetric method

(Limperos & Ranta, 1953), the field test based on this by Davies and Nicholls (1955) and the rapid field test of Edson (1958b) will be found as an annexe to the paper by Barnes, Hayes and Kay (1957) together with references to earlier accounts. A modification of the field test of Davies and Nicholls (1955), which it is claimed is easier to read, is given by Fleisher, Woodson and Simet (1956). Golz (1958) has described another variant.

Everyone who is responsible for the health of workers applying the moderately or severely toxic organo-phosphorus insecticides should arrange for periodical blood tests for cholinesterase activity to be taken and there is no technical reason why these should not be feasible under any conditions in which it is possible to apply pesticides at all. The simplest method used on a single occasion will be enough to determine whether an individual has suffered a severe depression of blood cholinesterase and is being, or in danger of becoming, seriously poisoned.

However, to follow trends and pick up the earliest deviations from normal in blood cholinesterase activity, account must be taken of the range of values found in normal populations (Callaway, Davies & Rutland, 1951; Wolfsie & Winter, 1952; Rider *et al.*, 1957) before the significance of the level in an individual can be assessed. The day-to-day value in healthy persons may vary from ± 13% for the red cell and ±20% for the plasma cholinesterase (Fryer, Steel & Williams, 1955). Similar variations in a small factory population were noted by Gage (1955). He suggests that if a person exposed to organo-phosphorus insecticide is found to have a cholinesterase activity of 50% or less of the average for the population he should forthwith be removed from further exposure. Levels of 50%–60% should act as an " alerting signal " for more care and the need for further tests.

Wolfsie (1957) has reviewed his experience of 5,000 tests done over a period of 10 years and recommends that plasma and red cell determinations should be done separately in order to get the maximum amount of information from the test. The pre-exposure levels are also valuable. Fryer and Williams (1956) have given their experience in the control of agricultural workers applying organo-phosphorus insecticides. While pre-exposure values are always useful in increasing the sensitivity of the test as an indicator of early poisoning, it should be remembered that the facilities available to the industrial physician such as Wolfsie (1957) will not be available to many in charge of public health programmes. They should not be deterred from using the simpler, cruder methods because they fall short of an ideal.

While the general surveys of Sumerford *et al.* (1953) indicated trends in one particular group of workers—*e.g.* the mixers of concentrates, using parathion—a survey of 245 farmers, pilots, mixers and others applying methyl parathion in Louisiana failed to disclose any depression of cholinesterase (Petty, Hedweg, Reinhart, Moore & Dunn, 1959). Fryer and Williams (1956) found 6 suspected cases of mild poisoning in a survey of 135 agricultural workers the majority of whom were handling parathion. All too frequently reports of occupational poisoning by organo-phosphorus insecticides include no record of any cholinesterase determination, indicating that no facilities were at hand. It seems likely that a team which is organized well enough to include regular blood cholinesterase determinations on its members will also have the rest of its routine well enough under control to reduce the risks of poisoning to a minimum.

Poisoning

The signs of acute poisoning by organo-phosphorus compounds have been described many times in the numerous accounts of cases of parathion poisoning. They have been summarized together with a few case histories from the literature by Barnes, Hayes and Kay (1957). Headache is common: this may be accompanied by miosis, but contracted pupils are not by any means always seen. Indeed dilatation of the pupils has been noted in authentic cases of parathion poisoning before atropine had been given (Dixon, 1957). Two important characteristics of parathion poisoning have repeatedly been stressed. The first serious symptoms may not develop until several hours after work has finished so the connexion between abdominal pain and occupational poisoning may not immediately be established (Delons, 1958). Secondly a single dose of atropine will often cause a striking but only temporary relief of symptoms.

Repeated exposure to organo-phosphorus compounds by teams of men working in a spraying season may produce lowering of the blood cholinesterase and some mild symptoms. These have been studied by Sumerford *et al.*, 1953 and Hayes, Dixon, Batchelor and Upholt (1957). The latter report observations in over 500 people during 3 seasons. They list selected symptoms with the incidence among different groups of workers who had varying degrees of exposure. Their list of symptoms includes: headache, nausea, fatigue, tightness of chest, abdominal pain, vomiting, loss of appetite. sweating, disturbance of vision, miosis, insomnia. They conclude that miosis together with 3 or more of the selected symptoms given above is strong evidence of mild clinical poisoning. This occurred much more frequently in the exposed groups (such as mixers and full time applicators) during the spraying season. The authors point out that this type of poisoning from long-continued exposure was never serious or fatal. Serious poisoning was always associated with " brief, massive exposure and gross carelessness ".

In a little-known paper Holmes and Gaon (1956) summarize their observations on 600 cases of poisoning from anticholinesterase agents which included war gases such as sarin, as well as insecticides. There are no details of how these men came to be exposed. One table shows that of 169 cases with a reduction of red cell cholinesterase of only 10% (*i.e.* still almost normal), 82% complained of tightness of the chest. This suggests exposure to vapour and as none of the commonly used insecticides are volatile the data implicate sarin as the major cause of poisoning in this series. A new feature in this important account is the evidence that repeated poisoning by these organo-phosphorus compounds could give rise to more persistent changes such as " dizziness, fatigability, impaired taste, numbness, irritability and confusion ".

The general features of the personality change were "forgetfulness and irritability". It is not possible to evaluate the significance of these observations in respect to the use of organo-phosphorus compounds in agriculture. Such possibilities must be borne in mind if men are employed all the year round applying toxic organo-phosphorus compounds in public health work as they now apply DDT or dieldrin.

The possibility that poisoning by organo-phosphorus insecticides may not be the result solely of effects on cholinesterase has been suggested by FRIBORSKA-WAELSCHOVA (1957) on the basis of a study of 11 cases. The careful surveys of HAYES *et al.* (1957) seem to exclude the likelihood of sequelae to mild exposure. Severe poisoning by any material is likely to induce long-standing subjective changes in some people. Whether or not organo-phosphorus insecticides are particularly prone to do this remains at present unproven. Serious persistent lesions from poisoning with these insecticides have been described for one material only—Mipafox (BIDSTRUP, BONNELL and BECKETT, 1953)—which is no longer marketed. Acute poisoning was followed by a neurological lesion clinically indistinguishable from ginger jake paralysis (tri-ortho cresyl phosphate (TOCP) poisoning). It was shown that Mipafox could produce a lesion in hens which was the same as that produced by TOCP (BARNES and DENZ, 1953). Many well-known organo-phosphorus insecticides were tested on hens but none was shown to be capable of producing this persistent type of paralysis (DURHAM, GAINES & HAYES, 1956). The isolated report by PETRY (1951) of polyneuritis in a man after exposure to parathion must have been a coincidence as no similar report has appeared despite hundreds of cases of parathion poisoning. Polyneuritis has been named as a sequel to exposure to several pesticides with a wide range of toxic properties and the case reports have the features described above (see under DDT). It is also impossible to attach much significance to the cases described by PETTY (1958).

The treatment of organo-phosphorus insecticide poisoning has long been based on the repeated administration of atropine in doses considerably greater than those usual for such procedures as preparations for surgical operations. 2 mgm. of atropine by intramuscular injection should be repeated every 30–40 minutes until the symptoms of poisoning such as colic or bronchial constriction are relieved or until mild atropine poisoning (dry mouth, warm skin and tachycardia) appear (BARNES, HAYES & KAY, 1957). The value and importance of early treatment with atropine combined with artificial respiration, where necessary, has been emphasized by FREEMAN and EPSTEIN (1955) in their analysis of 46 cases of severe poisoning with 23 deaths.

The injection of atropine is essentially symptomatic treatment as the drug counteracts the effects of an excess of acetyl choline at certain sites. Above all atropine protects the respiratory centre, interference with which is believed to be the cause of death in acute poisoning, but it does not prevent disturbances at the myoneural junction which interfere, among other things, with the function of the muscles of respiration. Hence the need for artificial respiration in some cases where atropine had been given (FREEMAN & EPSTEIN, 1955).

Arising from a study of the mechanism of the inhibition of cholinesterase by organo-phosphates has come the promise of a more specific therapy in anticholinesterase poisoning. The work has been conveniently reviewed and summarized by DAVIES and GREEN (1959). In the presence of certain reactive chemical groups such as hydroxylamines and oximes the inhibited enzyme can be induced to shed the phosphate moiety of the original toxic compound and become able once more to hydrolyse acetylcholine. The compound first shown to be therapeutically effective in animals poisoned by organo-phosphorus compounds was pyridine-2-aldoxime methiodide (P2-AM) (ASKEW, 1956; KEWITZ and WILSON, 1956). This compound has also proved effective in human poisoning by parathion. NAMBA and HIRAKI (1958) described 5 cases among many successfully treated by the intravenous injection of 1 gm. of P2-AM. ERDMANN, SAKAI and SCHELER (1958) and KARLOG, NIMB and POULSEN (1958) have described cases of attempted suicide successfully treated with P2-AM. In the case described by KARLOG *et al.* the patient developed signs of atropine poisoning from the large doses that he had received before the P2-AM was injected. With the restoration of cholinesterase activity acetylcholine will disappear and thus leave atropine to exert its effects unopposed. Although P2-AM has some therapeutic value when given alone, these therapeutic effects are greatly increased if atropine is given with it (ASKEW, 1957). Risk of atropine poisoning should not be considered a contra-indication to its early administration even if P2-AM may be available for use afterwards. The original P2-AM has been modified first by using the much more soluble methane sulphonate salt of pyridine-2-aldoxime (P2-S) (DAVIES, GREEN & WILLEY, 1959) and then by using coupled molecules such as N.N′ polymethylene bis (4-hydroxyiminomethyl-pyridinium bromide) (HOBBIGER & SADLER, 1959). Unfortunately P2-AM and related compounds are not effective against poisoning by all types of organo-phosphorus compounds. The well-known insecticide schradan being an example of one whose effects cannot be reversed (see DAVIES & GREEN, 1959).

Although it is unlikely that P2-AM would be given to anyone not already seriously poisoned there is reassuring evidence that P2-AM itself is not toxic to normal subjects should any error in diagnosis lead to its being given to a person not suffering from poisoning by an anticholinesterase (LADELL, 1958). Most of the P2-AM is excreted unchanged in the urine and the half life in the blood after a dose of 15 mgm./kgm. intravenously is 0·9 hour (JAGER, STAGG, GREEN & JAGER, 1958). There is every reason for ensuring that wherever men are exposed to parathion and related organo-phosphorus insecticides supplies of an appropriate reversing agent should be available as well as atropine. LADELL (1958) gives some advice on suitable methods for storing and dispensing P2-S.

DNOC

In the immediate post-war years di-nitro-*ortho* cresol (DNOC) was responsible for at least 8 deaths in

Britain when being used as a herbicide in the summer (BIDSTRUP & PAYNE, 1951). Scattered reports have come from elsewhere and DNOC and the related nitro-phenols have caused poisoning during manufacture (MALTER, 1949; SAITA, 1949). The toxic action of these nitrated phenols is well known. They stimulate metabolism by an effect of cellular respiration and in acute poisoning this may lead to death from respiratory and circulatory failure. In the subjects reported by BIDSTRUP and PAYNE (1951) who had been applying DNOC as a weedkiller in cereal crops, all except one had been working within 12 hours of death. This indicates the fulminating nature of poisoning by this type of compound. There is no specific therapy though the use of barbiturates should be avoided as they may enhance the toxic effects of DNOC (EDSON & CAREY, 1955).

There have been no accidents from DNOC in Britain in recent years. Not only are users more aware of the hazards as a result of legislation and publicity, but specific measures to detect absorption, by regular blood DNOC estimations, have been carried out among regular users. The technique for preventing DNOC poisoning is described by BIDSTRUP, BONNELL and HARVEY (1952) and HARVEY (1952). In locust control RAINEY (1958) has described the safe use of concentrated solutions of DNOC and prophylaxis has included regular blood DNOC determinations. STOTT (1956) described 2 cases of polyneuritis among these workers. The condition was very mild and rapidly cleared up after contact with DNOC had been stopped. The relation to exposure to DNOC remains uncertain.

Pentachlorophenol

Pentachlorophenol has a toxic action very similar to that of the dinitrophenols, and this is explained by the fact that they have a similar biochemical effect on cell metabolism (WEINBACH, 1954, 1956). Pentachlorophenol is used as a fungicide, herbicide and molluscicide. As a fungicide it may be used to dress timber by dipping cut planks in baths of it; deaths have been reported in France by TRUHAUT, L'EPEE and BOUSSEMART (1952) and in Sarawak by MENON (1958). As a herbicide it is used in pineapple cultivation and deaths from pentachlorophenol poisoning have been reported from Queensland (GORDON, 1956). Deaths have also been reported during the manufacture of pentachlorophenol (NOMURA, 1953). As with DNOC illness developed rapidly with all the evidence of an overstimulated metabolism—weakness and fatigue associated with profuse sweating followed by rapid collapse and death. In all the episodes the environmental temperature was high just as it was in the fatal DNOC cases in England. Few, if any, precautions were taken in handling the pentachlorophenol though as an industrial poison it is known as a skin irritant and the appropriate precautions are recommended. After 9 deaths had occurred in 18 months, among timber dressers safety precautions such as rotation of labour, the provision of protective clothing and washing facilities together with a reduction in the strength of the pentachlorophenol solution, MENON (1958) states that no further cases of poisoning occurred in the ensuing 18 months. As with DNOC there is no specific therapy, nor is there any test to detect absorption before intoxication supervenes. Pentachlorophenol has been used extensively as a molluscicide in bilharzia control work. Recently 2 fatal cases of poisoning have been described in men using the powder for this purpose (N. G. SHIRLEY, Private Communication). Its potentialities as a poison should therefore be borne in mind by anyone using it for this purpose.

Accidental Poisoning

There would be little profit in attempting to summarize or review the many reports of accidental poisoning due to pesticides that have not been directly related to exposure during their application. Such records are a memorial to human carelessness and do not differ from similar reports about many household chemicals, medicaments etc. that get into the wrong container, in the wrong place or into the wrong hands. For new chemicals, however, reports of such accidents and suicides do sometimes enable one to learn more about the lethal or toxic dose for man, the course of an attack of acute poisoning and any sequelae, and also the potentialities of a material for causing poisoning.

DDT. Poisoning in man has almost invariably been the result of DDT finding its way into food. A typical accident that poisoned 100 women is described by JUDE and GIRARD (1949) where flour was put into a container that had once held an insecticide powder. Only when the container was nearly empty did the flour contain enough DDT to poison those eating food made from it.

BHC. This has poisoned a number of children who found and chewed tablets containing it (SCHMIEDEBERG & WASSERBURGER, 1953; NICHOLLS, 1958) or swallowed an oily solution of lindane (BUCK & PFANNEMÜLLER, 1957). Despite severe convulsions, in several cases a complete and rapid recovery ensued. Barbiturates were given to the majority. Unfortunately no estimate of the doses received by the children can be made.

Aldrin. The clinical effects of a single dose of 25 mgm./kgm. taken by a 23-year-old male are well described by SPIOTTA (1951). In spite of intensive sedative treatment symptoms persisted for 12 days and EEG changes were present 46 days later. This is consistent with the fact that in occupational dieldrin poisoning symptoms may recur after exposure has ceased.

Endrin contaminated some flour in a sack which had been consigned in a railway wagon in which a leaking drum of endrin concentrate had previously travelled. About 100 people were poisoned from bread and cakes made from the flour and 30 of these had convulsions; the EEG readings taken in 7 cases were abnormal. Recovery here was rapid and complete (DAVIES & LEWIS, 1956). Unfortunately no estimation of the toxic dose could be made.

Chlordane is less toxic than aldrin to rats and also apparently to man. A girl swallowed an estimated dose of 32 mgm./kgm., in error for medicine. Symptoms developed 1½ hours later, culminating in convulsions 4 hours later. Thereafter recovery was rapid (DADEY & KAMMER, 1953). A child of 15 months was ill for 2 days after a dose estimated to be 10 mgm./kgm. of chlordane powder swallowed accidentally. The child was given barbiturates which controlled the symptoms (Lensky & Evans, 1952). On the other hand a concentrate of chlordane spilt on the clothes and not immediately removed caused the death of a women aged 23 within an hour. Another woman aged 32 deliberately swallowed a dose of about 104 mgm./kgm. as a powder and died 9 days later in convulsions despite continued therapy (Derbes *et al.*, 1955).

Malathion had little effect on a baby given a bottle to play with by another child, the contents of which it sampled (Goldman & Teitel, 1958), and in a quite unusual case a woman survived the swallowing of a malathion concentrate taken as a cure for toothache (Walters, 1957).

Parathion provides an altogether different story. Its popularity as a suicide weapon in Germany, Denmark and Finland may be explained by its availability in small ampoules and also to the statements in early cases that death was rapid and painless (Dr. G. Hecht, personal communication). Of its rapidity the numerous reports of suicide bear adequate witness (see Pribilla, 1955). Children have been poisoned as a result of playing with "empty" containers carelessly left around (Johnson, 1953). Large-scale poisoning has resulted from the contamination of food. One incident involving 200 people is briefly described in a report of 22 children who were poisoned, of whom 8 died (Wishahi *et al.*, 1958). In another incident over 1,000 people were poisoned, and more than 10% died, after parathion from a leaking container had contaminated food in a warehouse. From the report of the investigation into this incident it appears that the poisonous material was shipped and consequently treated as an innocuous material instead of being consigned properly (Government of India, Min. of Health, *Report of the Kerala and Madras Food Poisoning Cases Enquiry Commission*, 1958). Self medication by rubbing parathion in the skin to kill parasites caused a serious but non-fatal poisoning (Koeffler, 1958). Ignorance led to the death of an Indian worker who tasted the contents of a bottle of parathion out of curiosity (Anantaswamy, Gowda & Rao, 1957).

TEPP caused sudden death from a similar foolish act in America (Klendshoj *et al.*, 1952) and near fatal poisoning of a man who refreshed himself with a melon from a field he had just sprayed (Faust, 1949).

While it may be salutary to conclude with such reminders of the ability of some pesticides to kill or seriously poison people under some conditions there is also no doubt that with the simplest attention to the rules of good occupational hygiene, vast quantities of these materials can be safely used to the immense benefit of mankind.

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DATA ON PESTICIDES MENTIONED IN THE ARTICLE*

Common Name	*Chemical Name*	*Oral LD50 Rats (mgm./kgm.)*	*Percutaneous Single lethal dose Rabbits (mgm./kgm.)*
DDT	2,2-bis-(p chlorophenyl)-1,1,1,-trichloroethane	250	2800
DDD	2,2-bis-(p-chlorophenyl)-1,1-dichloroethane	2500	4000
Methoxychlor	2,2-bis-(p methoxyphenyl)-1,1,1,-trichloroethane	5000	>6000
BHC	Mixed stereo isomers of 1,2,3,4,5,6-hexachlorocyclohexane	1250	
Lindane	*Gamma* 1,2,3,4,5,6 hexachlorocyclohexane	125	4000
Chlordane	1,2,4,5,6,7,8 8-octachloro-2,3,3a,4,7,7a-hexahydro 4,7-methanoindene	250	800
Aldrin	1,2,3,4 10 10 hexachloro-1, 4 4a,5,8,8a-hexahydro 1,4,-endo, exo 5,8, dimethanonaphthalene	60	150
Dieldrin	1,2,3,4,10,10-hexachloro-6,7-epoxy-1, 4,4a 5,6,7,8,8a octahydro, 1-4 endo exo 5,8 dimethano naphthalene	50	250
Endrin	1,2,3,4, 10 10-hexachloro-6,-7-epoxy 1,4,4a 5,6,7,8, 8a octahydro-1, 4 endo endo 5,8-dimethano naphthalene	7♀ 40♂	125
Parathion	0,0,diethyl 0-p-nitrophenyl phosphorothioate	4	40
Methyl parathion	0,0,dimethyl 0-p-nitrophenyl phosphorothioate	15	300
Diazinon	0,0,diethyl-0-(2-isopropyl-6-methyl-4 pyrimidinyl) phosphorothioate	235	>4000
Malathion	0,0, dimethyl S-(1,2-dicarbo-ethoxy ethyl) phosphorodithioate	1200	>4000(rat)
DNOC	4,6 dinitro-*o* cresol	25	500(guineapig)
Pentachlorophenol	Pentachlorophenol	125	100
TEPP	Tetraethyl pyrophosphate	1·2	5

*Data from Handbook of Toxicology, Vol. III Insecticides W.B. Saunders. 1959, London and Philadelphia.

NEWS ITEMS

BLACK-FLIES AND ONCHOCERCIASIS

The flies of the genus *Simulium*, usually called black-flies or buffalo-gnats in English-speaking countries, affect man and animals both by their biting habits and by their role as vectors of parasites. In large areas of Africa, some districts of Central America, Venezuela, and perhaps other South American countries, species of this genus are vectors of human onchocerciasis. Over a much larger area, including parts of Canada, the U.S.A. and Europe, they are an extreme nuisance because of their biting habits and enormous numbers; in the U.S.A., for example, they used to put a stop to the tourist trade in the Adirondacks between May and July, and control measures became necessary in this area. *Simulium* has also created difficulties in the exploitation of fertile lands in Africa and Central America, not only because of the fear of onchocerciasis and onchocercal blindness, but also because, to avoid the ferocious biting of the black-flies, people refuse to work on the construction of dams, on irrigation systems or on the land. Populations have been forced to emigrate to other areas, and depopulation, famine, soil erosion, even social conflicts in territories where the emigrants were not welcome have resulted.

Heavy losses among domestic and wild animals have also been caused by *Simulium*. Animals have been affected in the river basins of Germany, along the Danube, in forested parts of Siberia, in Australia, Canada, the U.S.A. and South America, and include mules, horses, cattle, sheep, hogs, dogs, cats, deer, foxes, rabbits, turkeys, chickens and ducks. In Romania in 1923, for instance, more than 16,000 domestic animals were killed by *S. columbaczense*, in addition to an unestimated but certainly large number of wild animals.

Simulium transmits different parasites to different animals, one being *Onchocerca gutturosa*, a filarial worm that attacks cattle and causes severe economic losses in Australia. Another transmitted protozoiasis affects turkeys and ducks.

Different species of *Simulium* appear to have preferences for different parts of the human body. The North American black-flies are reported to bite man mostly on the upper parts of the body, even crawling under clothing and hats to feed. The head and upper parts of the body are also preferred by *S. ochraceum*, the principal vector of onchocerciasis in Guatemala and Mexico, while *S. damnosum*, the most important vector in most areas of onchocercal endemicity in Africa, bites almost entirely on the legs. These preferences appear to be correlated with the distribution of the "nodules" containing the adult *Onchocerca* worms in the person infected: in Central America they are chiefly found on the head and upper parts of the body, in Africa in the pelvic area and lower parts of the body.

Black-flies breed in running water, and both in Africa and in America control programmes are based on the introduction of such larvicides as DDT into breeding rivers and streams in quantities lethal to the larvae; but spraying has also been used in addition against adult black-flies, for instance in the Adirondacks. Control presents a very different problem in each area. In Quebec and in the Adirondacks the black-flies breed in the many streams, the country is difficult and the undergrowth dense, and roads and trails are absent; insecticide is therefore sprayed from the air. In Africa S. damnosum is generally a large-river species, and the breeding places are normally accessible from the ground, so that insecticide can be introduced into the main streams, the small tributaries, which generally are free of the larvae, being left untouched. The breeding places of S. ochraceum in Mexico and Guatemala are the most difficult to control, because the country consists of heavily fissured mountains with steep sides, covered with almost impenetrable tropical forest. Here aerial spraying is impossible, because the insecticide would never penetrate beyond the forest canopy, and the inaccessibility of the country and the abundance of streams make it exceedingly difficult to treat the breeding areas with insecticide.

With such different behaviour on the part of the black-flies, it is not surprising that there are striking dissimilarities in the epidemiology of onchocerciasis in America and in Africa. In Mexico and Guatemala, the disease is associated with coffee-growing areas and occurs in restricted zones in forested country between 450 and 1,500 m above sea level. In Nigeria, the endemic areas have such hazy limits that term "zone" is inapplicable; the disease is not associated with altitude or with plantations, and it is found both in savannah and in forest country. In Mexico and Guatemala the distribution of the vector black-flies is much more extensive than the distribution of onchocerciasis, whereas in Nigeria they are co-extensive. Finally, the infection rate in the black-fly is much lower in Mexico and Guatemala than it is in Nigeria, a difference than no doubt is reflected in the number of sufferers from onchocerciasis in the two areas: in Mexico this is estimated at 35,000-50,000, in Guatemala at 25,000, and in Northern Nigeria alone at a third of a million.

The author of an article in a recent issue of the WHO Bulletin (Crosskey, R. W. (1959) Bull.Wld Hlth Org., 21, 727), who has visited America as a WHO fellow to study black-fly control and problems of onchocerciasis, concludes from his comparison of American and African conditions that control should be based on a reasonable working knowledge of the biology of the local species, which may be different for the same species in different countries and under different conditions. Careful entomological studies are therefore essential for the planning of control measures in each area.

(WHO Chronicle, 1960, 14, (5), 189-190).

SPRAY DRIFT INVESTIGATIONS

Theoretical and experimental studies of the movement of spray particles projected into an airstream were made. It was shown that the mean paths were in agreement with the accepted law of resistance for semi-turbulent motion.

This result supports the measurements of drift which have been made. With conventional ground machine settings and operating conditions, 100μ drops are the largest which drift past a few yards downwind. Additives are therefore required to prevent drops below 100μ from appearing in the spray and this is achieved with several cellulose derivatives at concentrations of the order of 1% by weight. The use of such additives would be acceptable for aeroplane spraying but not for ground machines applying a minimum of 10 gal/acre.

The experimental trajectories also showed the value of keeping spray nozzles near the crop when spraying from an aeroplane. At a pressure not exceeding 10 lb/sq. in., 18 in. should be the maximum height above the crop. The nozzles should accordingly be retractable for safety.

At such low flying heights an aeroplane does not perform differently from a tractor except for the higher forward speed. At conventional flying heights of 4 ft. or more, on the other hand, the aeroplane performs as a drift sprayer in which distribution is controlled by air movement and not as a placement sprayer in which the spray is directed by the nozzles.

Robot aeroplanes flying low may, therefore, have important advantages as sprayers over conventional aeroplanes and promise to be cheaper. Work on these is continuing.

(Extract from National Institute of Agricultural Engineering, Annual Report 1958-59).

RESEARCH IN NEMATOLOGY AT IMPERIAL COLLEGE

A new nematology laboratory for Imperial College, to be built and equipped at the College Field Station at Silwood Park, near Ascot, Berkshire, at a cost of £30,000, will be the first university laboratory in the Commonwealth specifically staffed and equipped for research and training in this subject at post-graduate level.

Shell International Chemical Company, because of its world-wide interest in agricultural chemicals, is contributing £15,000 towards the cost of building and equipping the laboratory which, it is hoped, will be completed in time for the new academic year beginning next October.

Nematology is the name applied to the branch of zoology which deals with free-living and parasitic roundworms. Parasitic nematodes in vertebrate animals have been studies for many years, but less attention has hitherto been paid to the nematodes parasitic in plants and invertebrate animals.

The serious economic effects of plant nematodes on agricultural production have aroused concern in recent years, not only in this country, but in the F.A.O. and among the Colombo Plan signatories.

Under Professor B. G. Peters, who was appointed to a new Chair of Parasitology at Imperial College in 1955, work on this subject has been developing, and a full-time one-year course in nematology was started in 1958.

(Imperial College of Science and Technology, March 1960).

D.S.I.R. GRANTS FOR RESEARCH INVOLVING INSECTS

Dr. J. P. Stevenson (University College, London) has been awarded £2,100 for the study of immunity or the reaction to micro-organisms and antigens, which is of importance to the fundamental understanding of the chemical and biological control of insect pests.

Dr. H. B. D. Kettlewell's well-known work on industrial melanism on moths at Oxford University will continue. The rapid evolutionary change towards melanisation needs to be studied intensively while it is going on and a grant of £3,075 provides Dr. Kettlewell with assistance in this task.

CHEMICAL COMPOUNDS USED IN AGRICULTURE AND FOOD STORAGE IN GREAT BRITAIN

Recommendations, for safe use in agriculture and horticulture of the compounds noted below, have been added to those already included in the dossier prepared by the Ministry of Agriculture, Fisheries and Food.

"Allisan Dust" (2,6-dichloro-4-nitroaniline)	Revised:	June 1960.
Diazinon	Revised:	May 1960.
Phenylmercury Salicylate Aerosols	Revised:	May 1960.
Phosphamidon (2-chloro-2-diethylcarbamoyl-1-methylvinyl dimethyl phosphate)	Issued:	April 1960.
"Reglone" (9,10-dihydro-8a,10a-diazoniaphenanthrene dibromide)	Issued:	May 1960.
"Sevin" (1-naphthyl *N*-methylcarbamate)	Issued:	April 1960.

Copies are obtainable from:

Ministry of Agriculture, Fisheries and Food,
5/8, St. Andrew's Place,
Regent's Park,
London, N.W.1.

PEST CONTROL RESEARCH IN THE U.S.A.

1. Effect of systemic ("Thimet") on cottonwood growth: The cottonwood twig borer, *Gypsonoma haimbachiana*, stunts and deforms young cottonwoods by attacking terminals in much the same way that the tip moth injures pines. A preliminary study at Stoneville, Mississippi, reported last year, indicated that "Thimet", one of the recently developed systemic insecticides, may be used to reduce such damage.

These early results were confirmed on larger plots in 1959. Just before they were planted, several thousand cottonwood cuttings were dipped at least half their length in carbon dust containing 44 per cent of "Thimet". By the end of the growing season, only a few trees from treated cuttings showed injury by the twig borer, and these few usually had only one borer per terminal. Trees from untreated cuttings were heavily infested; in one plot they averaged 3.4 ft. smaller than the treated ones. Some treated trees were 16 ft. tall at the end of six months, having grown at the rate of about 1 inch per day.

The "Thimet" also gave protection against two leaf beetles, *Chrysomela scripta* and *Metachroma* sp.; a clearwing root and stem borer, *Paranthrene dollii*; and a leafhopper, *Homalodisca coagulata*.

"Thimet"-treated trees from the 1958 study were observed during their second growing season. All were attacked and damaged by the twig borer and other insects to the same degree as untreated plants of the same age. This indicates that supplemental treatments must be developed for the second and third years, if such protection is considered necessary. However, this inexpensive treatment of cuttings will protect the cottonwoods during their first season and help them to make enough height growth to compete with other vegetation.

(Annual Report 1959 of the Southern Forest Experiment Station.)

2. Cotton - Effect of "Thimet" and "Di-Syston"

Plant growth, fruiting time, and yield of cotton were studied during four years of research with systemic pesticides on cotton in Kern and Fresno counties. Both pesticides were applied by pre-planting seed treatment and by soil application. As a seed treatment both chemicals were applied at a rate of four pounds of active ingredient per 100 pounds of seed.

In the soil application the pesticides were applied as granules in the seed drill furrow, at two and four pounds per acre and as a side-dress, several inches away from the seed, at from 1.3 to 7.0 pounds per acre. Reduced stands were often observed where the pesticides were used, especially when planting was followed by cold, wet weather. Even under ideal growing conditions during one experiment, both chemicals reduced plant emergence.

Yield results during the four years of experimentation were variable. There was little or no difference in yield between the untreated check plots and seed, furrow, or side-dress treatments. Soil variability was largely responsible for yield variation, but none of the differences was significant.

(T. F. Leigh and V.T. Walhood. California Agriculture, 1960, 14, (2), 11.)

3. Insect Eradication

New methods of eradicating fruit flies will be field tested on small isolated Pacific islands by USDA entomologists. Small islands were chosen because their entire infested area can be treated easily and reinfestation can be controlled. One promising method to be tested is sterile-male release, which has proven so successful against the screw-worm. Great numbers of flies made sterile by radiation will be dropped from planes to mate with native flies. Since the resulting eggs do not hatch, the new generation is much reduced. Continued over-flooding with sterile males should eventually wipe out the flies. In other tests, poisoned lures to attract and kill males will be distributed a week or more before the flies attain sexual maturity. Continued use of this method also promises annihilation.

Treating insects so they will destroy their own kind is the aim of research suggested by USDA entomologist E. F. Knipling. He believes that there may be even more effective ways to control pests than the sterile male technique which has been used successfully in eradicating screw-worms in Florida, Georgia, and Alabama, and is now being tested with fruit flies.

Knipling suggests research along three lines: (1) Development of chemical compounds that will produce sexual sterility in both males and females in natural populations; (2) finding ways to contaminate or infect insects with diseases that will spread among their kind; and (3) breeding defective insects that will produce inferior progeny unable to survive. First, however, more basic information is needed about insects - their nutrition, mating habits, and other factors. Then any promising methods developed will have to be tested for practical effectiveness.

(Agricultural Research, March 1960, 8, (9), 8-9.)

4. Seed Alfalfa, Lygus Control

Recent experiments confirm earlier observations that toxaphene does not always provide adequate control of lygus bugs in alfalfa seed fields. It is more effective in early season applications and becomes less so as the season advances. Toxaphene in combination with "Phosdrin" or "Dylox" produced initial reductions in lygus populations which were similar to those obtained with "Phosdrin" or "Dylox". There were, however, indications that nymphs did not increase quite as rapidly when a toxaphene-"Phosdrin" combination was used. This was undoubtedly due to the longer residual activity of toxaphene against newly hatched nymphs.

Despite the fact that toxaphene tends to lose some of its effectiveness in late season applications, it is still the preferred material for lygus bug control in alfalfa seed. While toxaphene may not produce more than 50%-60% reduction of lygus populations, it tends to hold down the numbers of nymphs after it is applied. Increases in dosage from 3.0 pounds to 4.0 pounds of toxaphene per acre appear to improve control.

Certain of the organo-phosphorus compounds such as "Phosdrin", "Dylox", malathion, and "Phosphamidon" result in rapid initial kill of lygus bugs. They do not kill the eggs, nor do they remain active long enough to kill nymphs that hatch after treatment. Furthermore, these materials are highly toxic to natural enemies of lygus bugs. The latter increase rapidly in the absence of their predators.

(O. G. Bacon, J. E. Swift, V. E. Burton. California Agriculture, 1960, 14, (2), 5-6.)

5. European Red Mite, Control

The incidence of resistance to certain acaricides by the European red mite - Panonychus ulmi (Koch) - has increased severely during the past few seasons. The acaricides were organic phosphate compounds and such specific acaricides as "Ovex" and other closely related compounds, chlorobenzilate and "Kelthane". All of the observations on European red mite resistance in California have been from the field. Laboratory studies have not been conducted due to the difficulty of rearing this mite species under artificial conditions.

In an attempt to find a means of preventing or delaying the development of resistant strains, field trials in a Bartlett pear orchard near Marysville were established in the 1958 season. Bartlett pear foliage is very sensitive to spider mite attack. A mite population which reaches three or more mites per leaf will result in leaf burn and defoliation, especially if daily weather temperatures reach 90°F or above.

The spray materials, which had not been previously used in the test orchard, were "Ethion" and "Tedion" used alone and in conjunction with the non-specific compounds, summer oil ("Volck Supreme") and "Glyodin". Each trial plot was an acre in size and unreplicated. The sprays, applied with blower-sprayer equipment, varied from 900 to 1,000 gallons per acre.

With "Ethion" alone, control of European red mite was difficult the first season. The orchard had a history of mite resistance to other organic phosphates although "Ethion" had not been previously used. Four treatments were necessary in 1958, and the mites built up in the interval between sprays even though populations were sharply reduced immediately following each treatment. Leaf damage was evident by midsummer. In 1959 the populations continued to increase despite two applications, and both leaf burn and defoliation were widespread by early July when the plot was resprayed with another acaricide to avoid more damage.

The "Ethion"-"Glyodin" combination looked promising in 1958 although the mites did build up in August. In 1959, however, the mites were not controlled after two applications, and severe leaf burn and defoliation were evident by June, when the plot was resprayed.

The "Ethion"-oil combination gave very good control over the two-year period. The mite counts remained below economic levels, and there was no evidence of foliage damage.

With "Tedion", control was excellent with all combinations in the 1958 season. A few mites were encountered in late August on the "Tedion"-"Glyodin" plots, but no significance was attached to the count at the time. In the 1959 season, however, it was evident that the "Tedion"-"Glyodin" treatment was not providing control. The mites continued to increase regardless of the spray applications until severe leaf burn and defoliation occurred. In July it was necessary to discontinue the plot and spray with another acaricide. The plot treated with "Tedion" alone followed the same general pattern except that mites did not increase to damaging numbers as rapidly. In early July, following the first spray in May, the plot showed enough mites to warrant retreatment. After the second application on July 6, the populations did not decline and continued to increase until the trees showed leaf burn and defoliation. At this point, the plot was discontinued.

The "Tedion"-oil plot was outstanding in both 1958 and 1959. Not a single mite was encountered in any of the leaf samples, and the trees were free of any sign of mite damage. The plot was especially striking as it was located between the "Tedion" and "Tedion"-"Glyodin" sprayed trees, both of which showed extensive foliage damage.

One point that was illustrated as a result of the trial plots is the danger of repeated use of the same compound. Even though spectacular results are obtained in one season, complete failure may be encountered in the next.

(H. F. Madsen and P. H. Westigard. California Agriculture, 1960, 14, (2), 7-8.)

6. Soil Fungicides

Of approximately 2,000 chemical compounds tested as soil fungicides, not more than 10 warranted additional investigations in a systemic search for a safe, effective fungicide harmless to crop plants. One of the 10 promising compounds, "Terraclor", has effectively controlled root rot of beans and a limited number of other plant diseases.

Research on one of the dithiocarbamate fungicides shows that it kills soil fungi by first destroying their protective cell walls.

(J. B. Kendrick, Jr., California Agriculture, 1960, 14, (3), 8.)

7. Walnut Husk Fly

The first known parasites of the walnut husk fly - previously thought to be free of parasitic enemies - were found in southeastern Arizona in July, 1959, when two species were found on the foliage of black walnut trees at the Southwestern Research Station of the American Museum of Natural History. An adult female parasite was seen to oviposit in the husk of a larvae infested walnut. Later, an egg of the parasite was dissected from a larva of the husk fly. The discovery of the parasites in Arizona presages revived research in California on the biological control of the walnut husk fly.

(S. E. Flanders. California Agriculture, 1960, 14, (3), 8.)

8. Peach Tree Borer

Five insecticides, DDT, dieldrin, endrin, 'Thiodan' and 'Sevin', have been compared for effect against the Western peach tree borer, Sanninoidea exitosa graefi (Hy.Edw.). Two applications in the 1959 season - one in mid-May in advance of harvest and one in mid-July following harvest - were sufficient to span the long emergence period of the peach tree borer in California. Each material and dosage was applied to three trees with four replications in a randomized plot design.

Dieldrin, endrin, and 'Thiodan' were tested at dosages of 1.0, 0.5, and 0.25 pound of active ingredient per 100 gallons. 'Sevin' was used at 1.5 and at 3.0 pounds of active ingredient per 100 gallons and was compared with a standard dosage of DDT (4 lb. a.i. per 100 gal.). Instead of the usual DDT schedule of four sprays, the same two-treatment timing was used for all plots.

Materials were applied with a conventional high pressure spray rig and with hand guns. The pump pressure on the spray rig was reduced to 150 pounds per square inch to prevent splashing. A coarse spray nozzle avoided fogging of the spray and the consequent drift. The materials were applied to the tree trunks, from the main crotch to the soil line, in sufficient quantity to permit the runoff from the trunks to form a small puddle at the base of the tree. In this plot, a fraction over one gallon per tree was necessary to obtain the desired coverage. Prior to the treatments, weeds, sucker growth and dirt were cleared away from the base of each tree in the plot so the spray would not be blocked and result in poor coverage of the trunk.

Endrin and 'Thiodan' were effective at a dosage of 0.5 pound active ingredient per 100 gallons. There was no significant difference between the 1.0 and 0.5 pound dosages. When the dosages were reduced to 0.25 pound, however, the materials were significantly less effective. With dieldrin, the 1.0 pound dosage gave good control, but dilutions below this figure decreased in effectiveness. 'Sevin' apparently has little or no action against the peach tree borer, as there was no difference between the 'Sevin' treated trees and the check trees. DDT gave a measure of control when treatments were spaced at monthly intervals.

When 'Thiodan' endrin or dieldrin is used, extreme care must be taken to avoid contamination of fruit. Pump pressure must be reduced and a coarse spray nozzle used. Under no circumstances should a blower-spray be used. Hand spraying, with careful attention to confining the sprays to the tree trunk, offers the most readily controlled application.

(H. F. Madsen and R. R. Sanborn. California Agriculture, 1960, 14, (3), 10, 15.).

9. "Q-Lure" - New Attractant for Melon Fly

Modification of the chemical structure of anisylacetone-heretofore the best available synthetic attractant for melon fly - by chemists at the Agricultural Research Centre, Beltsville, Md., has yielded a chemical, 4-(p-acetoxyphenyl)-2-butanone, many more times effective. Since over one hundred other variations of the basic structure proved to be inactive, the specificity of this derivative poses an interesting problem. "Q-lure" has also been shown to attract another fruit fly species, *Dacus ochrosiae* in the Mariana Islands.

(United States Department of Agriculture, Press Release.)

NEWS ITEMS FROM THE COMMONWEALTH

AUSTRALIA

Codling moth control: A study was made of some aspects to be considered in experiments for the control of codling moth in apples.

Examination of the number of fruit damaged by either deep entries or stings in samples of 100 fruit showed that the counts of damaged fruit could be considered as random samples from a Poisson (or binomial) distribution both within trees and also in plots up to a size of four test trees.

An optimum plot size and sampling procedure was determined in experiments for the control of codling moth in apples. A single-tree plot with four samples per tree is optimum for unguarded plots, and plots of either one, two, three, or four trees with four samples per tree are satisfactory for guarded plots where the trees are hand-sprayed. Guarding seems an unnecessary safeguard and expense for hand-sprayed plots. Where "Air - Blast" spray machines are used, large plots with a double guard row are necessary, and it is sufficient to examine two to four samples per tree.

It is suggested that Smith's heterogeneity law can be used to obtain the optimum plot size in experiments for the control of insect pests, and possibly of diseases on fruit trees.

No reduction in experimental error was obtained by using the crop size of individual trees as a covariate in an analysis of covariance. (K. M. Cellier.)

Control of citrus red scale: Heat treatments, ranging from 50 to 70°C and for varying durations, were carried out on freshly picked Washington Navel fruit infested with red scale. Counts of the living and dead scales were made 3 weeks after treatment.

The time-mortility curves were approximately sigmoidal and similar to normal dosage-mortality curves. Reliable 100 per cent "kills" were obtained for treatment periods ranging from 1 hour for the 70°C treatment to 2¼ hours for the 50°C treatment. However, the fruit damage effects of the 70°C treatment were severe and preceded the time required for 100 per cent scale mortality, whereas with the 50°C treatment no fruit damage occurred until after this time and even then the damage was very slight.

Raising the relative humidity of the treatment chamber from 12 to 40 per cent in the 50°C treatment did not significantly alter the time required for either 50 per cent or 100 per cent scale mortality. It is considered that the killing of the scales was a temperature rather than a dehydration effect, and that it probably occurred at a fairly similar threshold lethal temperature for all temperature treatments used. (B. H. Martin and R. F. Black).

(Journal of Agricultural Research, March 1960, 2, (2), 186, 197.)

Earwig Control: Earwigs which have appeared in plague numbers during recent years in the Melbourne area and in some country districts, can be controlled by spraying with 0.25% dieldrin emulsion. Dieldrin is the most effective of the readily available insecticides.

The dieldrin emulsion should be applied on a fine day to the walls of buildings up to the window line, to paths, bases of fences, rockwork, trunks of trees and shrubs, foliage near ground level and the surface of garden beds. Ornamental plants may be sprayed safely, but vegetables and fruit (except root vegetables, and vegetables such as beans and tomatoes when they have no fruit) must not be sprayed. Dieldrin is quite safe to handle provided normal precautions are taken. The spray should not be inhaled. Dieldrin will not harm domestic animals or birds, but it is very poisonous to fish. Dieldrin will stick to sprayed surfaces for weeks in spite of rain or heavy watering and will kill the earwigs by contact as they crawl about at night. One treatment will substantially reduce the earwig population on a treated area very rapidly and, provided there is no migration from surrounding land, a single treatment should be sufficient to control earwigs throughout the summer.

Dieldrin may be obtained in concentrated form from nurserymen. One pint of 15% dieldrin emulsion, diluted with 7½ gallons of water, is sufficient to treat a 50 ft. by 150 ft. house block.

(Victoria Department of Agriculture, Biology Branch. Journal of Agriculture, Victoria, 1960, 58, Pt.3, 159.)

AUSTRALIA - SOUTH

Lucerne

Red-Legged Earth Mite: The red-legged earth mite, (Halotydeus destructor, Tuck.), is a pest of crops and pasture in nearly all districts of South Australia. Principal crops attacked are clovers, lucerne, peas and linseed. Other types of pasture plants may be damaged, as well as some kinds of vegetables, cereals and fodder crops. The mites suck the plant sap and leave large whitish to silvery blotches on the leaves. Where there are heavy infestations in seedling plants, serious losses may result. On older crops the damage is less severe but herbage and seed yields are reduced.

The red-legged earth mite is a deep bluish-black insect, with bright red legs and is about the size of a pinhead. Large numbers of mites can often be seen running over the ground surface as well as on plant stems and leaves. Mites build-up in weed-infested areas, especially where capeweed is dominant, as well as in pasture. The mites carry through the summer in the egg stage. The eggs hatch about two or three weeks after the first autumn rains, provided the soil temperature is below 70°F. About three to four weeks later the mites mature and begin laying eggs for the next brood. There are several broods a year, depending on weather conditions.

Lucerne Flea: The lucerne flea, (*Sminthurus viridis* L.), infests lucerne, clover, cereals and grasses in most districts of South Australia. It is often associated with red-legged earth mite infestations; consequently, control measures are usually combined. Young pastures may be seriously damaged. Older paddocks usually recover later in the season, but autumn and winter feed is greatly reduced. The lucerne flea is a chewing insect. It attacks the leaves, eating out the tissue between the main leaf veins. Young lucerne fleas only make small holes in the leaves, but older insects may consume the greater part of the leaf.

The lucerne flea is pale green to yellow green in colour and about the size of a lucerne seed. It hops vigorously when disturbed. Lucerne fleas carry through the summer in the egg stage. These eggs hatch two-three weeks after the first autumn rains. The fleas from these eggs mature in 4-5 weeks and then lay eggs themselves. In this way several generations are completed in the one season.

Control Measures

Red-Legged Earth Mite:

2-5 weeks after opening rains -	Spray with 8 fl oz. 25% DDT in 3-10 gal. water per acre.
or	Topdress with 2 oz. pure lindane per acre mixed with superphosphate in the normal fertilizer programme.
After 5th week	Topdress with 4 oz. pure DDT per acre mixed with superphosphate.

Lucerne Flea: Spraying two to three weeks after the first opening rains with 1 fluid oz. of 50% malathion miscible oil in 3-10 gal. of water per acre gives excellent control. For older infestations the amount of malathion should be doubled.

Red-Legged Earth Mite and Lucerne Flea Present:

2-5 weeks after opening rains -	4 fl. oz. 25% DDT plus 1 fl. oz. 50% malathion in 3-10 gal. water applied as a spray.
After 5th week	8 fl. oz. 25% DDT plus 2 fl. oz. 50% malathion in 3-10 gal. water.

(R. G. Dent. Journal of Agriculture, South Australia, March 1960, 63, (8), 332-333.)

CANADA - NEW BRUNSWICK

Spruce budworm: Reports concerning the spruce budworm outbreak resulting from surveys in the summer and fall of 1958 indicate that the risk of damage is decreasing and no spraying operation has been recommended for the summer of 1959. The forests which have been protected by spraying are in a much improved condition compared with the previous year and the outlook is encouraging.

Aerial spraying: Aerial spraying operations by Forest Protection Limited in 1958 covered all of the high hazard areas indicated by egg and defoliation surveys of 1957. This included about 2,700 sq. miles of critically damaged forest in previously sprayed areas and 1,300 sq. miles of new high hazard in Victoria, Carleton and York Counties. Operations were carried out from nine of the previously-constructed airstrips and Fredericton Municipal Airport. The spraying fleet included 70 Stearmans and, for the first time in New Burnswick, 12 T.B.M. Grumman Avengers. Costs were the lowest of any of the New Brunswick operations - averaging 60c per acre. Dosage was at the customary rate of $\frac{1}{2}$ lb. DDT in $\frac{1}{2}$ U.S. gallon of oil-solvent per acre.

Balsam woolly aphid, Adelges piceae (Ratz.): The winter of 1957-58 was very favourable to the aphid and it recovered rapidly in many parts of the Province from the severe winter of the previous year. The introduced predators that had become established before the severe winter were reduced in numbers but survived and increased during the past year. One of these, Laricobius erichsonii, gave further evidence of its capacity to control stem attacks before the tree is killed.

Work on biological control continued and further introductions were made, including a species from Australia and another from Japan.

These both reproduced in the forest but their ability to survive the winter is not yet known. In the effort to establish a strong complex of natural enemies, other predators are being sought in India and Pakistan through the Institute of Biological Control of the Research Branch and the Commonwealth Institute of Biological Control. A visit was made to Switzerland and Germany and conditions seem favourable to the collection and introduction of further material in 1959 from Central Europe. The role of each of the predators in natural control is being carefully studied. In general, they have reduced the severity of attack but other species are needed if the killing of trees and the loss of growth from 'gout' disease is to be prevented.

(122nd Annual Report of the Department of Lands and Mines of the Province of New Brunswick for the Year ended 31st March, 1959.)

GHANA

Agriculture

Cocoa: The Cocoa Campaign in conjunction with the Department of Social Welfare and Community Development continued and served a useful purpose in arousing awareness amongst farmers of the need to control pests and diseases and to adopt improved methods of cocoa husbandry in general. The progress of the campaign was reflected in the increased sales of spraying equipment, and issues of insecticide and in the larger area of land lined and pegged for new plantings of cocoa. A total of 11,234 sprayers were sold at subsidized prices and some 29,000 gallons of "Didimac" insecticide issued free of charge to farmers. Towards the end of the year "Gammalin 20" (BHC) was substituted for "Didimac" (DDT) insecticide. Farmers responded satisfactorily when asked to purchase the Gammalin at subsidized prices.

Cocoa Storage: An experiment on the effect of dusting prepared cocoa beans with lindane quality BHC was started in co-operation with the Pest Infestation Laboratory at Slough. After treatment half the cocoa was sent direct to United Kingdom for processing and half stored for six months before being despatched. Chocolate prepared from these consignments will be tested for taint.

Cocoa Capsid: From the assessment of results obtained in field trials towards the end of 1955-56, a standard treatment of control of capsids in mature cocoa was evolved, namely:-

> The application using a mistblower, of 1 pint "Gammalin 20" (i.e. 4 oz. gamma BHC toxicant) in 5 gallons of spray per acre with a second application four weeks later. Thereafter control of

capsids is maintained by means of regular inspection and spraying of localised areas only, carried out as new damage is observed.

The programme of work in 1956-57 was concerned mainly with establishing the best time for application of the standard treatment, the means and efficacy of retreatment and the assessment of the degree of "build-up" of capsid population permissible before retreatment is essential.

The assessment of results revealed that:

(1) When dealing with small units of approximately five acres (or less) the degree of infestation was largely dependent upon the extent and intensity of damage in the surrounding cocoa, but that where the canopy is fully re-established there seems to be some deterrent to re-infestation.

(2) The standard treatment proved equally effective whenever applied, but there was no doubt that capsids are more wide-spread and hence re-infestation more likely during the period December to January. Thus, the application of the standard treatment at that time would mean that the cocoa would remain free from re-infestation for the longest period. There was no doubt that the initial standard treatment should be carried out as soon as feasible on all damaged forms. It was considered that the standard treatment followed by routine overall mistblowing using 1 oz. toxicant per acre in June, July and again in November and December is sufficient to keep any farm free from severe capsid damage.

(3) Retreatment spraying should be carried out as soon as possible after damage is observed and should consist of application of wash at the rate equivalent to 1 oz. gamma BHC (i.e. 5 ozs. "Gemmalin 20" per gallon of water) to the damaged trees and those trees within five paces. Retreatment spraying should be repeated four weeks afterwards. Hand spraying equipment was equally as effective as motorised equipment although more tedious to use.

(4) Whilst both dusts and fogs gave reasonably good results they were inferior to mistblowing.

(5) Yield increases were again most pronounced although they were naturally greatest where capsid damage had reduced yield to a very low level before treatment began. This is clearly shown in the yield data from recorded plots reproduced in the table below:

Summary of Yield Increase over Three Years (Main Crop Yield)

Average Yield per Acre of Units During the First Season of Spraying (grouped into classes)	No. of Plots (Units)	Percentage Increase in Average Yield Per Acre Over 1954 (the 1st Year of Treatment) 2nd Year of Treatment	3rd Year of Treatment
Under 100 lb/ac.	2	244	623
100-200 lb/ac.	8	112	244
200-300 lb/ac.	4	78	156
300-400 lb/ac.	2	19	68
400-600 lb/ac.	2	15	120
Over 600 lb/ac.	1	4	43

Early in 1957 a standard recommendation was made for capsid control treatment in young cocoa of 28 cc's of 'Gammalin 20' to one gallon of water applied by a pneumatic knapsack sprayer. Five to ten gallons of spray are normally used on one acre. Spraying is advocated in June/July and November/December.

Cocoa-Black Pod: In trials in the Aburi area spraying pods with 0.3% "Perenox", both with and without "Agral" wetting agent, gave yield increases of 35% to 55% on numbers of pods although the percentage of black pods fell by only 20%. Furthermore statistical analysis of the 1954-56 black pod control extension trials has shown that low volume applications of "Perenox" increased yields of pods by 20% to 55% whilst percentage of black pods only decreased by 3% to 10%.

Cocoa-Swollen Shoot: Two series of control experiments were laid down:

(i) On a large scale on 400 acres of cocoa near Oyoko in the Swollen Shoot devastated zone and

(ii) On 76 discrete outbreaks located mainly in the Bosuso, Begoro, Kibi, Osino, Kankang and Nkawkaw areas.

Spraying of dieldrin at the rate of 1 lb. toxicant per acre commenced in December, and was repeated in two to three months' time in both the large and small scale units, applied in 22 gallons of water per acre by mistblower. Twenty gallons were applied to the trunks of both cocoa and forest trees by gangs traversing a strip once in each direction, and an additional machine put two gallons per acre of dieldrin wash, up into the cocoa canopy to control capsids.

Twenty of the discrete outbreaks were also sprayed in March with malathion, a specific mealybug killer, at the rate of 4 oz. toxicant per acre. It was thought that the breaking down of the mealybug carton nests would enable malathion to take effect. Very substantial reductions in ant and mealybug populations were noticeable as a result of the dieldrin spraying, particularly on the extensive sprayed areas at Oyoko. Figures for visibly infested and contact trees removed from the different treatments are accumulating but it is likely to be a year or more before any results will become apparent.

Termites: From the results of a simple trial, it was possible to recommend a treatment for the protection of young cocoa and coffee plants from termites. Aldrin was the most economical of the insecticides tested although chlordane, dieldrin and lindane were also effective. The following treatments were recommended:

(a) For cocoa or coffee in the field add 42 cc's of aldrin concentrate (20% emulsifiable liquid) to 5 gallons of water and apply ½ gallon of the mixture per plant watered around the roots to a radius of 12 to 18 inches.

(b) For nursery beds 1 gallon diluted insecticide (as above) per square yard of bed.

Machinery: Facilities were developed during the year for the maintenance of spraying machines employed on the extension spraying programmes. With the assistance of Messrs. Plant Protection and the Kent Engineering and Foundry Ltd., the first servicing depot was set up at Bunsu, at which all the new machines were assembled, tested, calibrated and run-in before despatch to the teams operating in the field. Some 580 machines were dealt with in this way. By the year's end four servicing depots were operating - one in each cocoa growing Region.

It was found by experience that after 200 hours running the mist-blowers should be returned to the depots for complete overhaul. As was to be expected, some major engine troubles, at the beginning, resulted from ignorance or neglect on the part of the operators. The commonest faults, however, were due to unforseen failures of such items as fan belts, air cleaners and rubber hoses. Shortage of spare parts accounted for many problems but this difficulty was gradually being overcome.

Another new and important service performed in the course of the year was the testing of new types of sprayers which came into use when the BHC insecticide replaced DDT. The Mysto 46 and the Yaresafo types were proved to be efficient machines suitable for use by farmers. Long lance ancillary equipment was developed for attachment to these machines for operation in mature cocoa.

Maize - Stem Borer: In Ashanti the areas which had two free issues of 5% DDT were expected to buy their own insecticide in future, and extension work was concentrated in adjacent districts.

The Entomology Division carried out extension work in two new areas around Oda (Southern Ghana) and Adaklu (Southern Togoland). At Oda dusting with DDT reduced the percentage of plants attacked at tasselling stage from 40% to 2%. At Adaklu results were less encouraging and the farmers less co-operative.

Stored Insect Pests: Farmers in North Ashanti purchased during the year enough gamma BHC to protect from stored insect pests more than 500 tons of cob maize in cribs.

An experiment on five methods of storing maize cobs showed:

(a) the best of the treatments was dusting the cobs minus sheath with 12.5 parts per million of gamma BHC. This killed both the rice weevil, (Calandra oryzae), and the rice moth, (Sitotroga cerealella), whereas 5 p.p.m. gamma BHC did not kill the latter.

(b) In the absence of insecticidal treatment best results were obtained by selecting sound cobs with long and complete sheath covers and storing the cobs in their sheaths.

In a trial at Babile, dusting with 0.5% BHC or fumigating with an ethylene dichloride - carbon tetrachloride 3:1 mixture successfully protected sorghum and millet against insect damage, the BHC treatment being slightly the better.

Coffee: Rust, (Hemileia vastatrix), was present in Eastern Region and Ashanti as well as Togoland. Leaf spot, (Cercospora coffeicola), appeared to be common in some Departmental nurseries. Chlorosis of robusta seedlings at Koforidua was shown to be due to iron deficiency and trials showed that two sprayings of 1% ferrous sulphate and a wetter at monthly intervals was the optimum treatment.

(Annual Report of the Department of Agriculture for the Year 1956-57).

Tafo Research Station

Cocoa

Virus research: The collaborative experiments with the Ghana Division of Agriculture on the capsid-spraying of virus-infected cocoa have received the first insecticide treatment. Fifty-six plots have been established at four centres, and yields are being recorded on about 10,000 trees. Some plots have responded spectacularly to the clearing of the undergrowth and weeds in areas of neglected infected cocoa. In some of the more exposed sites the infected trees have deteriorated more rapidly than had been expected. For instance at Ampem, on the southern margin of the Afram Plains, 96 of the 1,600 trees died during the first six months; rather more than half of these were on plots that had been sprayed.

Black pod: Attempted control of black-pod disease by use of light mineral oil has continued. A steady rise in the amounts of the disease in both treated and untreated plots has occurred.

Cushion-gall: Transmissions to seedlings were first made by feeding mealybugs (*P. njalensis*), collected from a gall at Maase in the Eastern Region, on to 5 healthy cocoa beans. Of the seedlings which developed, 3 produced galls from the axillary bud of the cotyledon. Since then further transmission using *P. njalensis* and *Ferrisiana virgata* have been successful both from other galls collected at Maase and from a gall found at Tafo. However, mechanical transmissions without using mealybugs have also been successful. Although the possibility of a virus being the cause has not yet been eliminated it is thought that the most likely pathogen is a bacterium. Bacteria isolated from galls are now under inoculation tests.

Mealybug: The first application of dieldrin treatment has been completed on old plots in the Joint WACRI/Division of Agriculture trial covering Bunso, Bosuso and Osino areas. Second applications have been commenced. Fortnightly ant and mealybug population counts are being maintained.

The number of virus infected and contact trees cut out in the treated area has now increased considerably and the encouraging initial results of ant control followed by decline in mealybug population and swollen shoot incidence are not being maintained. The situation is not clear and is being investigated further.

In all, seven systemic insecticides have now been screened on seedlings through soil, leaf-painting and spray applications. Tasting tests, for occurrence of taint, are being carried out on two of these insecticides.

Ibadan Substation

Cocoa, Black pod: The use of a proprietary cuprous oxide formulation as a standard in all the laboratory fungicide tests has been abandoned. Standard laboratory Bordeaux Mixture, prepared according to the recommendations of the American Phytopathological Society's Committee on standardization of fungicide tests is now used in its place.

Using this standard a number of fungicides have been re-examined for their initial toxicity according to the methods outlined in the Annual Report. Once again the results suggest that the three copper oxychloride formulations examined were inferior to three cuprous oxide formulations when applied at the same concentration of copper. In all cases the differences were significant at 0.1%. An analysis of variance is applied to the spot number counts after the transformation $X = \sqrt{(X + 1)}$ has been made. The Duncan multiple range test (Biometrics II, 1-42, 1955) is applied to examine the significance of the means. Standard laboratory Bordeaux Mixture would appear to be the best fungicide so far examined. It must be remembered that these tests do not take into consideration the weathering properties of the various formulations.

A preliminary experiment, using an improvised settling tower fitted with a spray nozzle from a hand atomizer suggests that it will be feasible to use a slide germination technique to estimate the efficiency of a number of fungicides suitable for black pod control. An exploratory calibration of the deposits obtained on glass slides in the settling tower was made using Aniline Blue dye, the colour being measured in an absorptiometer. Although the uniformity of the deposits was good (considerably better than that on pod surfaces using the horizontal sprayer) a final calibration will not be made until a new nozzle can be fitted.

Further tests suggest that zoospores of P. palmivora will fulfil all the requirements of a test organism suggested by McCallan et. al. (Contr. Boyce Thompson Inst. 12, 49-77, 1941) except that they are not very easily countable. Sporangia are not suitable because of the difficulty of producing larger numbers under controlled conditions, and because the percentage germination after 20 hours is often poor.

Provided that the physical difficulties of this technique can be overcome it is hoped that the results will corroborate those obtained by the pod spraying method.

Field Studies: At the request of the Department of Agriculture a field trial is being conducted at Owena, Ondo Province, to compare the efficiency of three proprietary cuprous oxide formulations and "Carbide Bordeaux" Mixture for the control of black pod disease. The experiment is laid down in the form of a randomized block with ten replicates of each treatment. Each plot contains 20 trees. There are no unsprayed controls, the "Carbide Bordeaux" plots being taken as a standard. Records are kept of the numbers of healthy and diseased pods removed at each harvesting date. The cuprous oxide formulations are each applied at a concentration of 0.4% and the Carbide Bordeaux at a concentration of 1% which are the concentrations recommended by the Ministry of Agriculture and Natural Resources, Western Region, for farmers' use.

All the fungicides are applied from pneumatic knapsack sprayers fitted with the nozzles recommended to farmers as being suitable for black pod control spraying.

Harvesting and recording commenced on May 20th and spraying on May 21st, and have since been carried out at 3 weekly intervals. At the time of writing the main crop is beginning to ripen and after the recent heavy rains black pods are common on all plots.

(West African Cocoa Research Institute, Quarterly Progress Report, No. 55, July-September, 1959.)

INDIA

Agricultural Research

Ecological studies on 'Phadka' grasshopper showed that no nymphs emerged from egg pods buried in an inverted position while 12 per cent and 50 per cent of the nymphs emerged from the egg pods buried sideways and in the normal position, respectively. Thus the beneficial effect of ploughing was indicated. Dieldrin, aldrin and gamma-BHC dusts, tried against first instar nymphs, proved equally effective against the pest. Studies on the jowar borer indicated that the pest does not undergo a true physiological diapause although development is considerably slowed down. Also it was shown that the climate of any part of India could not act as a limiting factor against the existence of this pest. For the first time it was possible to rear the painted bug to an adult stage on mustard seeds. In an effort to evolve a spraying schedule against mustard aphid, it was observed that four sprayings of gamma-BHC and

Pestox III during the active season of the pest were effective. The temperature effect of insect susceptibility to fumigation by carbon disulphide and ethylene dichloride, as observed on a common stored grain pest, showed that there was a complex interaction between pre-fumigation, fumigation and post-fumigation temperatures on the mortality of insects. Bioassay studies showed that DDT film is the most toxic among the various insecticides tried, namely DDT, endrin, isodrin, dieldrin, aldrin and gamma-BHC, against adults of a weevil (Myllocerus). Contrary to normal expectations, carbon tetrachloride was found to be superior to the EDCT mixture when used in bins containing wheat. In tests with pyrethrum, the synergistic effect of the piperonyl butoxide was demonstrated by the fact that as low a dose as 0.0025 per cent of pyrethrin emulsion alone gave a mortality of 63.3 per cent among adults of the red pumpkin beetle, whereas the same dose with piperonyl butoxide gave 96.6 per cent mortality.

On the studies of the effect of contact insecticides on the infestation of stored grains it was found that at Delhi the infestation in cowpeas went up to 87.2 per cent in the untreated portion but in the grains treated with some dusts it ranged between 3.0 per cent and 7.2 per cent. Similarly, the infestation in wheat went up to 53.3 per cent in the untreated lot at Pusa (Bihar), as against 0.0 per cent to 7.7 per cent in some of the dust treatments.

Studies on the 'Khapra' beetle, one of the most resistant among the stored grain pests, revealed that the extraordinary resistance of the larval stage is lost even at the pupal stage and the adult is quite susceptible. It appeared that the insecticides, lindane, aldrin and dieldrin can easily be depended upon for the safe preservation of at least seed grain against this dreaded pest.

Radioactive tracer studies: Preliminary studies indicated that the parasite of potato tuber-moth, fed with 25μ c of P^{32} per gram of 10 per cent glucose solution per parasite, did not become radioactive to the tracer level whereas doses of 50μ c and 100μ c under similar conditions made them radioactive. Parasites feeding on normal 10 per cent glucose solution were irradiated with P^{32} and it was observed that a dose of 250μ c produced little activity in the parasites while a dose of 500μ c produced slight activity after 24 hours of irradiation. Full-grown host larvae were made radioactive and later on given for parasitisation. The viability of the eggs and the fecundity of the parasite seemed to have been adversely affected.

Soil treated with radioactive phosporus for periods ranging from one to three months was examined for quantitative and qualitative changes in the flora of fungi and actinomycetes. In the initial activity range of about 90 to 400 microcuries per 10 gm of soil, an increase in the numbers of fungi and actinomycetes was noted at the lower levels up to about 180 microcuries. The numbers dropped at higher levels, but were still more than in untreated controls. No qualitative changes were apparent at any level.

Seed dressing: Replicated field experiments were continued to determine the relative efficacy of 8 commercial fungicides on the emergence, stand and yield of maize, bajra, wheat and barley crops. A majority of the seed dressings tried showed beneficial effect. Ceresan, in the case of maize and bajra, Agrosan GN in the case of wheat, and Spergon in barley were the most effective fungicides and gave maximum increase in grain yield.

In the Aretan treatment of sugarcane setts, appreciable increase in the number of millable canes and yield of crop was observed in the plots planted with the treated setts.

Termite control: In a field experiment on wheat during 1955-56 aldrin, dieldrin and chlordane at concentrations of 0.25%, 0.5% and 1.0% were sprayed in the furrows at the time of sowing at 16 gallons/acre. Damage ranged from 2.1% to 5.1% in the treated plots as against 7.3% in the control; dieldrin at 1% strength showed least damage.

The residual effect of the various insecticides used during 1954-55 was assessed in terms of percentage damage of the crop, tillers per plant and yield of grain. So far as damage to the crop was concerned, tech. dieldrin at all rates (5, 10 and 15 lb/acre) and DDT + BHC and DDT + toxaphene at only higher rates (15 lb/acre) gave better results as compared to control. There was however very little difference in tillering or yield of grain between the treated and untreated plots.

(From Scientific Reports of The Indian Agricultural Research Institute for the year ending 30th June, 1956; Delhi, 1958).

Heliothis armigera, control: Insecticidal trials were conducted against Heliothis armigera Faler at Government Farm at Tharsa (Nagpur) and Powerkheda (Hoshangabad). BHC 5 per cent, chlordane 5 per cent and toxaphene (50 per cent wettable) were applied in the form of sprays at 0.16 per cent concentration. It was observed that only DDT 5 per cent (dust) and DDT 0.16 per cent concentration (spray) were significantly effective after 24 hours of application. After 48 hours of the application, individually all the treatments were significant over control. These may be arranged in the following order of merit - DDT 5 per cent, DDT 0.16 per cent, chlordane 5 per cent, toxaphane 5 per cent, BHC 5 per cent and BHC 0.16 per cent concentrations.

Liver fluke disease, control: A scheme has been running in Mysore with the object of studying the efficacy of chemotherapeutic agents and other measures in the control of liver-fluke disease under field conditions in heavily irrigated areas. It was observed that anti-snail measures, such as drainage, copper sulphate spraying, etc., are neither useful nor practicable. Systematic dosing of the susceptible animals was found to be a cheap and useful weapon for the control of the disease.

(Annual Report of the Indian Council of Agricultural Research for 1956/57).

Coconut pest control: Entomological investigations at the Central Coconut Research Station, Kayangulam comprising studies on the various pests of the coconut palm have yielded results which are of practical importance to the growers. They are enumerated below:-

1. The rhinoceros beetle, (*Oryctes rhinoceros* L.), may be successfully controlled by the systematic collection of the beetle from the crown of the palms by the beetle hook and its destruction, spraying the breeding places of the beetle with insecticide (BHC 5% wettable) and the prophylactic treatment of the palms by filling their inner leaf axils with a mixture of sand and BHC (5% dust at the rate of ½ lb. per tree).

2. The coconut caterpillar, (*Nephantis scrinopa* Meyr) can be brought under control by the judicious destruction of the pest-infested leaves and the use of 0.2 per cent DDT as foliage spray. This pest can also be checked to a certain extent by the liberation of its natural enemies, i.e. parasites in fields where DDT is not used as foliar spray.

3. The palm weevil, (*Rhynchophorus ferrugineus* F.) attack may be prevented by protecting the palms from injuries and the prophylactic treatment of leaf axils, filling them with insecticides. Injection of "Pyrocon-E" into the trunk is an effective curative measure.

4. Infestation of the cockchafer beetle, (*Leucopholis coneophora* Burm), in coconut gardens is significantly reduced by ploughing in either 5% BHC at the rate of 56 lb. per acre or 5% chlordane at the rate of 28 lb. per acre.

Investigations conducted on the control of coconut diseases with special reference to the leaf-rot and root (wilt) disease indicate that in general adoption of proper cultural practices and regular manuring improve the vigour of the palms. Foliar spraying with copper fungicides like Bordeaux mixture three times a year controls leaf-rot.

(The Indian Central Coconut Committee, Fourteenth Annual Report, 1st April, 1958 to 31st March, 1959).

MALAYA

Rubber pest research:

Termites: In continuing tests of residual toxicity to Coptotermes curvignathus of soils treated with chlorinated hydrocarbons, dieldrin still retained its lethal character after four years in both lateritic and volcanic soils and in two sandy loams. Its toxicity in clay soil had been lost after 34 months. Aldrin, chlordane and endrin had already lost their activity in the six soil types studied. In peat soil, all the materials quickly lost their effectiveness when applied at the usual dosage rates. Aldrin has proved more effective in this type of soil than dieldrin - at twice the standard dose aldrin retained its toxicity for nine months whereas soil treated with dieldrin became non-toxic after five months. When the dosage was increased **fourfold** in peat soil the periods of retained toxicity were fourteen and nine months respectively. Even at four times the standard rate, chlordane lost its toxicity within one month.

A high degree of correlation has been shown to exist between the persistence of aldrin and endrin in different soil types with cation exchange and moisture holding capacity of the soils. There is however, no significant correlation between effectiveness and percentage organic matter or clay content.

Cockchafers: Of the seven estates which in 1957 suffered severe cockchafer infestation, four reported re-infestation again this year. A small experiment was laid down on one of them where the cockchafer, Holotrichia bidentata, was active, to find out whether the legume cover Pueraria could be saved by chemical treatment of the soil. Aldrin and gamma BHC emulsions were injected at the rate of 6, 10.8 and 13.8 lb. aldrin and 2.4, 4.4 and 5.6 lb. gamma BHC per acre. Examination of the cover after treatment showed that all insecticides were successful in protecting the Pueraria. No difference above ground could be noted between the treatments and dosages, but the number of live grubs was progressively lower with each higher dosage.

On two other estates, where aldrin was used in 1957 for the protection of young trees against the grubs of Holotrichia bidentata, this treatment effectively protected the trees from a severe re-infestation this year.

Soil samples from the collar region of trees treated in November 1957 with four pints of 0.1% aldrin or 0.4% gamma BHC emulsion were assessed for their residual toxicity. Grubs of H. bidentata were confined in the two soil samples and in an untreated soil as control.

Those confined in the soil treated with aldrin were all dead within five days but those in the gamma BHC soil and in the untreated control continued to feed normally and completed their life cycle. The superior residual toxicity of aldrin was indicated.

Miscellaneous: A severe infestation of Tetranychus telarius on Pueraria phaseoloides has been controlled by spraying with 0.1% "Tedion V.18" wettable powder alternated with 0.12% of malathion.

Rubber disease research

Bird's eye spot: Control experiments have been continued in nurseries heavily infected with bird's eye spot. In the early part of the year tests were undertaken with six fungicides, Bordeaux mixture (4:5:40) "Perenox", "Trifungol" (ferbam), "Triscabol" (ziram), captan and mercurised copper oxychloride, applied at weekly intervals with a motorised knapsack low-volume sprayer. Mercurised copper oxychloride, which in previous trials had given an indication of its superiority in controlling the disease, again proved to be the best. None of the other fungicides tested showed much promise. Lack of coverage appears to be part of the reason for the failure to secure adequate control and trials are now aimed at overcoming this defect by the use of a spray oil as carrier for the fungicides in conjunction with the use of a low-volume mist blower. Copper and mercurised copper fungicides are being used.

(Annual Report 1958, Rubber Research Institute.)

Public Health

Bioassay of wall deposits: At the request of the World Health Organization, two different kinds of apparatus for making bioassays of insecticide deposits on walls were tested, to assess the relative merits of each. Panels were marked out on a wooden wall and treated with 50 per cent wettable powders of DDT (200-300 mg/sq. ft.) and dieldrin (approx. 100 mg.). Females of Aedes aegypti were then confined for one hour, or for 30 minutes, on the treated surfaces in the apparatus provided, and then transferred to clean lamp chimneys and the kill recorded 24 hours later. The tests were repeated at weekly intervals, and one apparatus (cone) was found rather easier to use than the other (dish).

The opportunity was taken to include the organophosphorus insecticide malathion in the tests. There was no information on how long malathion would last as a residual insecticide in Malaya, and it was important to get some information as it had been recommended for use against bed bugs resistant to DDT and dieldrin (see later).

The results of the tests were interesting. DDT gave a very poor kill even when fresh, and LD50 tests showed that the strain of Aedes aegypti, which was from the laboratory colony, had a very low susceptibility to DDT, lower than when first colonised. Dieldrin was still giving a kill of over 90 per cent in the fifth month, while malathion at 50 and 100 mg/sq. ft. gave kills between 60 and 80 per cent in the third month, dropping abruptly to under 30 per cent in the fourth month. The malathion thus had an effective duration of three months which was better than had been expected.

Resistant Bed Bugs: During the first half of the year reports were received from three rubber estates and a mental hospital of bed bugs not being controlled with the usual residual insecticides. In two instances the trouble followed quickly on the use of dieldrin. There was no opportunity at the time to measure the degree of resistance but also no reason to doubt the reports. Malathion emulsion at about one per cent was recommended and is reported to have given good results, bugs remaining absent or uncommon for three months or more.

Head Lice: House spraying with dieldrin at 100 mg/sq. ft. at Ubai and Pulau Rusa as part of the filariasis research programme has led to the virtual elimination among school children of the head lice Pediculus humanus capitis. In an unsprayed area a high rate of infestation was recorded among girls and boys.

Culicidae: Work has been continued on the systematics and biology of the culicines.

Filariasis - vector control:-

Insecticide Control: House-spraying with dieldrin at 100 mg/sq. ft. in Ubai (population 350) at first sight appears to have had some effect on transmission since the microfilaria rates and loads have fallen from 40 to 26 per cent and from 17.5 to 4.5 per cent respectively over the 1953-1958 period. However, pre-treatment survey figures of the Pahang Tua Irrigation Area show that a similar drop in infection rates occurred between 1953 and 1957. The overall decrease is more in Ubai than elsewhere, but clearly it is impossible to state that insecticide spraying has been solely responsible for the reduction.

Combined drug and insecticide control: Dieldrin spraying in Pulau Rusa (population 700) was commenced in 1957 and has been continued at 6-monthly intervals. Mass treatment of the population with diethylcarbamazine at 5 mg/kg body weight was given in May and June.

(Annual Report of the Institute for Medical Research for 1958.)

NEW ZEALAND

Sheep: lice and keds control: A report is given of a trial comparing dieldrin, aldrin, diazinon and ronnel against body lice, Damalinia (Bovicola) ovis and keds, (Melophagus ovinus), on crossbred ewes with three months' wool. One quarter gram of insecticide was applied in each case by spraying or dusting over the whole sheep. Treated animals were run with a comparable number carrying heavy infestations. All four insecticides gave much the same period of protection against reinfestation: about 15 weeks for lice and 20 weeks for keds. The need for a second treatment (two months later) in most circumstances is indicated.

('Control of lice and keds', R. L. Taylor, E.M. Oxnam & W. K. Marris, N.Z. Journal of Agriculture, Feb. 1960, 100 (2), 119-20.)

WESTERN SAMOA

Coconut - Rhinoceros beetle control, Crown treatment: It may now be said that BHC treatment is an effective way of protecting palms from the rhinoceros beetle; and provided the expense is warranted, (as for treatment of marginal damage) it can be confidently recommended. The dieldrin treatment is beginning to show results and may well supercede the BHC treatment if treated palms continue to progress for the next six months, at the rate they have improved so far. BHC treatment is being used by a planter at Fasito'outa on 450 palms; and during 1960, it is planned to use dieldrin treatment on 2,000 palms in Savai'i.

Biological control: Attempts to breed up the parasitic Scolia wasps to increase the local population were made without success. The Entomologist, who is a member of the S.P.C. Advisory Committee on Oryctes, visited Suva for consultations and to study control work being carried out there. The S.P.C. Insect Pathologist working on diseases of the beetle spent three weeks in Samoa during which a large number of specimens were examined. Dr. Surany reported that local beetles seem to display different trends in behaviour and are more likely to kill the coconut palms here than in Asia or Africa. He collected several hundreds of beetles for study in his laboratory in Africa. It is hoped that the results of these studies will assist the control of the beetle by the use of disease-causing organisms.

Banana - stem weevil: The beneficial predator (Placsius) introduced in November 1957 for the control of the stem weevil, was recorded at Avele on October 5. It had already been recorded from Solosolo and Falelatai where it was released last year; but this is the first record of Placsius away from these places, and a good indication of its establishment in Samoa.

Coffee - root fungus: A trial at Lepale for control of cicada nymphs, using aldrin, "Vapam" and formalin 0.5%, gave a fair response to formalin, and no response to aldrin, suggesting that the fungus was the cause of the trouble, rather than the cicada nymphs. The "Vapam" treated sites have not yet been replanted.

Cocoa - bagmoth: This pest was treated at Lefaga and a study made of its parasites. There has been no further trouble at Leauva'a with this pest which is controlled by the parasitic fly Tachina psychidarum, an insect not previously recorded in Samoa.

Longhorn borer: Continues to cause damage to bark and branches, particularly in old and neglected plantations. A trial using "Dieldrin Special" was made at Tanumapua in November; but it is as yet too early to assess its effectiveness.

Citrus - moth damage: An unidentified Arctiid moth has been observed causing slight damage to the leaves of citrus plants at Fasito'otai and at Sataua, Savai'i.

Crop dusting equipment: A large number of very effective simple and cheap hand bellows for dusting crops with insecticides were made by the Department from a design drawn up by a United States agency operating in Indonesia. These machines, costing only a few shillings each, are made of local waste materials; and many of them were used in the field work on banana bunchytop virus to destroy the insect vectors. They also proved very useful for dusting taro and other crops infested with gaogao and anufe (caterpillars). A full description was published in Laufasi Ola 1959, 4 (4).

(Department of Agriculture, Forests, and Fisheries, Annual Report for 1959, Apia, Jan. 1960.)

NEWS ITEMS FROM THE COLONIAL TERRITORIES

EAST AFRICA

Larvicides: In spite of the present emphasis in the anti-malarial use of insecticides on the attack against adult mosquitoes, larvicides still play a very important part in the prevention of malaria in East Africa, and various forms of application have received attention. Assistance was given in the assessment of trials of a granular formulation of dieldrin, first applied by hand and then, after this had proved successful, from aircraft. The very great advantage of this type of preparation in dealing with breeding places that are overlain by vegetation was abundantly proved. Attempts to find or develop a machine for application from the ground are continuing.

A further enquiry into larvicidal formulations concerned the need for the addition of spreading agent to larvicidal oils containing a chlorinated hydrocarbon such as DDT. It was found that the assumption of the necessity for this additive, to increase the rapidity and effectiveness of spread on the water surface, was in fact unfounded.

An investigation into the formulation of mosquito larvicides has been to compare larvicides containing BHC with those containing DDT, rather to the disadvantage of the former; but, provided allowance be made for their relative efficiencies, BHC can be regarded as a more economical substitute for DDT.

Mortality to Larvicides containing DDT and BHC

Larvicide	Dosage cc/sq.yd.	24-hour Mortality		Source of Test Insect
		Treated	Control	
DDT 5%	0.025	94	7	Insectary
	0.05	100	8	Insectary
BHC 0.5% gamma	0.05	11	7	Insectary
	0.25	52	14	Insectary
	0.25	50	8	Wild Caught
	0.5	91	10	Insectary
	0.5	90	6	Wild Caught
	1.0	100	7	Insectary
BHC 0.75% gamma	0.05	9	8	Insectary
	0.25	66	2	Insectary
	0.5	98	7	Insectary
	0.75	98	8	Insectary
BHC 1.0% gamma	0.05	5	3	Insectary
	0.25	78	11	Insectary
	0.5	98	7	Insectary
	0.5	95	9	Wild Caught
	0.75	100	7	Insectary

100 Fourth stage larvae of A. gambiae were used in each case.
The "wild caught" larvae were the bred-out progeny of wild caught females.
0.5 cc/sq. yd. is equivalent to 2 quarts/acre.

Studies with Radioactive tracers: During the course of the year radioactive tracers were used for marking both sexes of *Anopheles gambiae*, in order to follow up their movements and survival after release. The radioisotopes used were Phosphorus-32 and Sulphur-35, both of which emit beta-rays, and are consequently safe to handle, and easy and fairly cheap to obtain from the United Kingdom. Detection of the labelled mosquitoes was by an autoradiographic technique.

Results

Flight range: The average distance flown before capture was between half and three-quarters of a mile. There was an initial phase of concentration round the release point during the first two days, followed by a phase of dispersion over a wider area during the next two days. After that, no progressive spread of the population with increasing age could be detected. The average flight range of those released from the periphery, where there were few houses, was slightly greater than of those released from the centre of the recapture area, where there were two sizeable villages. Migration outwards from the release point was influenced therefore by the number of houses in the vicinity, and catches fell off steeply with increasing distance. But while most of the recaptures were made at three-quarters of a mile and less, three females were caught at a range of nearly two miles, the greatest distance at which catching stations were maintained. If the number of catching stations at each range is also taken into account, the recaptures, plotted on a logarithmic scale, decline in a linear fashion indicating the random nature of dispersal.

The flight range of males was greater than expected. While 60 per cent of males were caught in the quarter-mile range, as compared with 40 per cent of females, individual specimens were encountered at all distances, and one male was caught two miles from the point of release 2 days later.

As already found in experiments with paint-marked mosquitoes, the direction of the prevailing wind had relatively little effect on movement; but, at times when the wind was particularly strong, a definite tendency to fly further with than against it was observed, although even then a substantial number of mosquitoes was recaptured up wind of the release point.

Survival: As would be expected, a relatively high proportion of mosquitoes was recaptured during the first few days after release. The average age at recapture was 6-7 days, and small numbers of females were caught 21-23 days after release.

A daily mortality rate of 14-15 per cent has been calculated for females labelled with isotopes. The mortality rate of females marked with paint was slightly higher than this, being 16.5 per cent. In both sets of data, if the recaptures at different ages are plotted on semi-logarithmic paper a straight line is obtained. This confirms the deduction, made tentatively in earlier experiments, that the mortality rate of the released mosquitoes remained essentially the same at all ages.

The estimated daily mortality rate is considerably higher than that calculated from the age structure of natural populations of A. gambiae. The longevity of the insectary reared mosquitoes is thus less than that of naturally occurring insects, and this finding is confirmed by the much lower sporozoite rate among the former.

On the other hand the longevity of released male mosquitoes was unexpectedly high. It is commonly thought that males are short-lived insects. Yet it was found from these experiments that their average age at recapture was only slightly less than that of females, and the oldest mosquitoes caught in the whole series was a male aged 30 days.

(Annual Report of the East African Institute of Malaria and Vector-Borne Diseases, July 1958-June 1959).

Schistosomiasis: Surveys including the examination of urine and stool samples from school-children for the presence of Schistosoma haematobium and S. mansoni have been made on the West side of Lake Victoria. No evidence of infection was found on the mainland, but S. mansoni in school-children has been reported on some islands about 25 miles south of Bukoba.

A search for snails has been made in the area. On the mainland a few Biomphalaria were found in Lake Ikimba, south-west of Bukoba. The almost complete absence of snails from the West Lake mainland is considered to be of interest. The results of water analysis indicate differences in waters (and therefore presumably soils) from the west and east sides of the lake - the former being almost chemically pure, with low conductivities compared with the latter. Water samples were sent to Professor Beadle at Makerere College, Kampala, who is hoping to establish some relationship between water characteristics and the presence or absence of snails.

In order to study cercarial densities in natural waters, the technique described by Rowan (1957) is being tried, with slight modifications to suit local conditions. A concentration technique which depends on the negative geotropic and positive phototropic characters of the cercariae, is also being developed. If successful, it should enable live cercariae to be obtained for detailed study.

(East Africa High Commission. East African Institute for Medical Research, Report, 1958-59.)

FIJI

Coconut stick insect control: Control of the stick insect, *Graeffea crouani* Le Guillou, has been a difficult problem in Fiji. On young palms, to which insecticide can be applied by a knapsack sprayer or a power duster, control is simple. However, most of the palms which have been severely attacked have been very tall, and have been growing in areas where wind is a problem. Some planters claim to have achieved control by lighting piles of dead fronds, rubbish, etc., sometimes with addition of sulphur, throughout the affected area on a still hot day. The hot air causes the insects to fall to the ground. The writer has had no experience of this method, but greatly doubts its efficacy.

A power duster has been tried, but failed to give satisfactory cover of the fronds of tall palms. Stick bands round the trunks, with and without added insecticides, have also been tested. These caught large numbers of young nymphs, and some adults and older nymphs, but did not cope satisfactorily with an outbreak. The reason for their failure probably was that there were sufficient eggs in the axils of the fronds to keep the infestation going.

The only effective answer to the problem of applying insecticides to tall palms appeared to be the use of aircraft. However, this was not seriously considered, as it was thought that the cost per acre of spraying scattered and small areas would be prohibitive. In 1959 a local aircraft company fitted a Tiger Moth aircraft with a spraying outfit, and discussions revealed that spraying could be carried out at an economic cost.

Aerial spraying trial: It was decided that the Department of Agriculture should pay for a spraying trial on an experimental plot of 100 acres. A suitable area, where considerable damage was being done to old palms, was found in a plantation on the island of Taveuni. Laboratory tests had shown that BHC and dieldrin were toxic to the stick insect, DDT being ineffective. BHC was chosen for use in the trial, the objective being to apply it in oil solution at the rate of 4 oz. and 8 oz. of the gamma isomer in two gallons of dieseline per acre on two contiguous areas of 50 acres each. The plots were each about 60 chains long and $8\frac{1}{2}$ chains wide.

The spraying outfit consisted of a tank to contain the insecticidal spray, which fed the fluid to a boom fitted to the trailing edge of the lower wing of the aircraft. There were 24 nozzles spaced one foot apart along the boom. Pressure to force the liquid through the nozzles was provided by a wooden propeller, operated by air pressure. Preliminary trials showed that nozzle apertures of 1/32" would give about the desired output of spray fluid per minute when the aircraft flew at 60 miles per hour and treated one row of coconuts at a time.

Before spraying the trial plots, an estimate of the population of stick insects was made. Approximately one-third of the fronds of typical palms were cut and lowered to the ground, where they were placed on a tarpaulin and the insects on them were counted. The sample included a fair proportion of fronds of varying ages. From the counts made, the population of the whole palm was calculated. The estimated populations of five sample palms were 118, 124, 141, 168 and 206, the average being 147 (4 male and 2 female adults and 141 nymphs). The high proportion of nymphs to adults and of young nymphs to more mature ones showed that the population was increasing. By a misunderstanding, the population counts were made about six weeks before spraying was carried out. It is thought probable that, at the time of spraying, populations would have increased.

The spray fluid was made up by adding the appropriate quantity of a BHC solution containing 20% of the gamma isomer to drums of diesoline, after drawing off an equal quantity of oil, and rolling the drums back and forth to mix the fluids.

The first plot of 50 acres was sprayed between 2 p.m. and 3 p.m. and between 5 p.m. and 6 p.m. on May 18. There was rather too much wind, with the result that the aircraft had difficulty in maintaining its course, and had to fly somewhat higher than had been intended. At 3 a.m. the following morning rain began to fall, 20 points being recorded. The rate of application on this plot was supposed to be 8 oz. of the gamma isomer of BHC in two gallons of spray fluid per acre. Actually 10 oz. of gamma isomer in 2½ gallons of spray fluid per acre was applied.

The second plot, of which the planned application rate was 4 oz. of the gamma isomer of BHC in two gallons of spray fluid per acre, was treated on May 19, between 10 a.m. and 11.30 a.m. Here again there was too much wind, and the actual rate of application was 4.4 oz. of the gamma isomer of BHC in 2.2 gallons of spray fluid per acre. During the afternoon, a few points of light rain fell between 3 p.m. and 5 p.m.

In both plots a quick knock-down of stick insects was obtained, the affected insects beginning to fall within an hour of the time of spraying. They continued to fall, in diminishing numbers, during a period of three days after spraying. No newly-hatched nymphs were found on sprayed palms until the fourth day after spraying, indicating that the residual effect of the treatments lasted for three days. The lower rate of application appeared quite adequate to give a heavy mortality, and there was no advantage in using the higher rate.

When spraying had been completed, estimates of populations of stick insects were again made by counting those found on fronds cut from palms in the treated plots. The results of these counts are shown in the table below.

As the original populations were of the order of 150 or more per palm, a very high percentage of mortality is indicated.

In theory, a second spraying would be necessary to bring about a high degree of control. In practice this might not always be necessary, because the population of stick insects may sometimes be declining naturally at the time when the second treatment is due. The object of a second spraying is to kill the insects which have hatched from eggs dropped before the first spraying. It should be so timed that it is applied after all the eggs have hatched and before insects arising from the earliest hatchings have had time to mature and begin laying the next generation of eggs. A study of the life-history figures show that this period is four months.

Costs Reasonable: Costs involved are reasonable, especially when copra prices are at a high level. The cost per acre of the BHC and diesoline mixture at 2 gallons per acre and 4 ounces of the gamma isomer works out at about £stg.8/-. If the spray fluid were made up by dissolving 99% Lindane (the gamma isomer of BHC) powder in diesoline, the cost would be about £stg.7/- per acre.

Cost of the aircraft would vary widely, according to the extent of the area to be treated, proximity of a landing strip, distance of the plantation from the aircraft's headquarters, type of aircraft used, etc. A sum of £stg.1/-/- per acre should cover most cases, so that total cost of insecticidal spray and application would be less than £stg.30/- per acre for one treatment.

Estimated Populations of Stock Insects in Treated Plots

Period after spraying	10 oz. Plot		4.4 oz. Plot	
	Number of Palms sampled	Calculated Population per palm	Number of Palms sampled	Calculated Population per palm
1 day	2	91	2	24
2 days	2	31	1	Nil
3 days	2	22	1	12
4 days	1	10	-	-
9 days	2	5	2	Nil

(SOUTH PACIFIC BULLETIN, January, 1960.)

GRENADA

Agricultural pests

Banana: leaf spot, (Mycosphaerella musicola): This year a total of 124,007 acres were sprayed using 50,952 gallons orchard oil, 4,838 lb. "Perenox" and 5,163 lb. copper oxychloride. This represents 9.8 cycles per acre on the average registered acreage during the year under review. A 21 day spraying cycle was maintained in most areas and during the wet season this was reduced to a 15 day cycle in all areas that are specially susceptible to leaf spot. As a whole control was quite efficient in the lower coastal areas but proved to be a difficult task in the humid, elevated regions, where infection remained medium to high for most of the wet season. Panama disease, (Fusarium oxysporum £ cubense): This disease is still prevalent on many estates where Gros Michel is grown. As there is no established cure it is the policy of this department to encourage planters to replace the Gros Michel by the resistant Lacatan strain, and many farmers have been doing so during the year. Borer, (Cosmopolites sordidus): The use of aldrin both as a dust and spray on new and existing fields has resulted in a greatly reduced incidence of this pest. Its control really presents no problem. It is of interest to note that this pest cannot fly, so that a fair amount of control can be had by simple crop rotation.

Cocoa: (Witches' Broom, (Marasmus perniciosus): Some 43,219 acres were traversed and in the process 33,770 trees were pruned in an effort to control Witches' broom. Thrips, (Selenothrips rubrocinctus): Using dieldrin in combination with either 'Albolineum' or 'Agral', a total of 1,504 acres were sprayed to control this pest. Beetle, (Steirastoma breve): This pest gave little or no trouble this year, a fact which is attributed, at least partially, to periodic spraying of interplanted fields with orchard oil for banana leaf spot control. There is no scientific evidence for this belief, but it is a feature which might be well worth investigation.

Sugar cane froghopper, (Aeneolamia varia): Approximately 329 acres were sprayed with dieldrin or dieldrin/aldrin for control of this pest, and on the whole control was good.

Moth borers, (Diatraea spp.): In 1957 a survey of moth borer damage showed an average joint infestation of 10.6% with a range of 3.3 to 15.2%. It is proposed to carry out a survey early in 1959, to determine the intensity of infestation which from preliminary observations, is expected to be somewhat higher. Investigations indicate the need for vigorous control measures especially if we bear in mind the fact that for every one per cent of joints bored 0.3% sugar is lost.

Rodents: There have been many reports of damage to various economic crops by rats. Sugarcane has been badly damaged and a number of coconut trees in the Paradise (St. Andrew) area has been partially defoliated.

(Report on the Department of Agriculture for the Year 1958.)

HONG KONG

During the period under review Extension and Advisory Services gave assistance to 317 farmers and visited 115 villages both for assistance and instruction. A total area of 2,538.6 dau chung* was sprayed and included 449.2 dau chung of orchards, 1,985.2 dau chung of paddy, 33.9 dau chung of vegetables and 70.3 dau chung of miscellaneous crops.

In addition to these normal duties the team was called in to deal with a serious outbreak of leaf roller moths and leaf roller skippers on the second paddy crop, first discovered at Kau Lung Hang, Sha Tau Kok and Ta Kwu Ling. A serious calamity was averted by prompt action. Farmers were organized into team under the control of extension staff and Government met half the cost of insecticides used. In this way 4,168 acres of land (involving 2,636 farmers of 252 villages) were sprayed. 161 knapsack sprayers (many of them gifts to villagers by the Kadoorie Agricultural Aid Association) and 173 gallons of concentrated endrin were used.

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* 6 dau chung = 1 acre.

Plant pest research: Seven fungicidal preparations and twenty three insecticides were tested out against diseases and pests of field, vegetable and orchard crops; many of these preparations will find a use in local agriculture. By arrangement with a local firm formulations of different percentages of parathion and malathion were prepared for trial against the flea beetle which is a destructive pest of vegetable crops.

On account of its toxicity parathion is not permitted for general use as an insecticide although it is in most cases a superior insecticide. The purpose of this experiment was to find out if a safe preparation involving parathion could be used as a general purpose insecticide. Mixtures, (24% parathion, 56% malathion) and (16% parathion, 64% malathion) gave excellent kills with no measurable difference between the two preparations. Good results were also secured with a preparation containing 8% ethyl parathion and 72% malathion.

(Annual Departmental Reports 1958/59, Director of Agriculture Fisheries and Forestry.)

KENYA

Stored products: Several stacks of maize were covered with light polyethylene sheeting (0.0025 in thick) and fumigated. The polyethylene was then left in place for the storage period as a barrier against reinfestation. This technique appears most promising and larger trials are anticipated. Though the polyethylene is not as gas-tight as neoprene sheeting the gas losses are not significant when large stacks are thus treated.

The maize control shell concrete store in Nairobi - the Ctesiphon - was rendered gas-tight and methyl bromide gas was released directly into the store for a five-day fumigation of about 100,000 bags of badly infested maize. The results were excellent: the infestation in the stacks was controlled, the stores residual beetle population was killed, flying moths were controlled and the cost was less than that which would have been incurred had the individual stacks in the store been fumigated under gasproof sheeting. From the technical aspect the most important points were the small amount of gas needed and the thoroughness of the gas distribution though no expensive gas recirculating equipment was used.

Coconut - Coreid bug: Bio-assay work with several DDT formulations, dieldrin, BHC and pyrethrum has been carried out during the year and is now nearing completion. Using an "Agla" syringe for topical application, dieldrin has been shown to be about five times as toxic to Pseudotheraptus as DDT. The insect is relatively highly resistant to pyrethrum, whether synergized or not, although the use of piperonyl butoxide as a synergist at eight times the pyrethrum content increases toxicity fourfold. Although pyrethrum gives a quick knockdown at high dosages, activation of the insect is not very marked, and it appears unlikely that addition of pyrethrum to other contact sprays will markedly increase their effectiveness. Biological assays of residues at different times after application of a variety of residual insecticides have shown dieldrin and DDT to be the two most promising. Absorption of DDT has been investigated and found to be of no great significance. For the different formulations, an emulsion and a crystalline suspension, applied as full cover sprays at 0.5 per cent active ingredient, only 20 per cent to 40 per cent of the DDT was absorbed.

Many substances were tested in an effort to find an attractant for Pseudotheraptus to enable the formulation of poison baits, but none were discovered. Four systemic insecticides were assayed biologically with disappointing results.

Cotton pests: In a dusting trial, DDT/WC1 was found to be superior to both DDT/malathion and endrin/malathion. No pronounced red spider build-up occurred this year and it was therefore not possible to compare these dusts for acaricidal properties. At Hola, sprays of endrin with or without malathion, and DDT with BHC proved superior to toxaphene and DDT with malathion.

District trials on African-grown cotton have shown that pest attack can be strikingly reduced by the use of insecticides. Results so far available from the lakeshore area show yields increased from 290 lb. seed cotton per acre (50 per cent stained) to 700 lb. per acre (20 per cent stained) by either 60 or 80 lb. of a 3 per cent gamma BHC/10 per cent DDT dust. In both treatments the insecticide was applied in five equal lots at ten-day intervals.

In the wetter Elgon Nyanza areas spraying of 4 lb. of DDT per acre (four applications at ten-day intervals) increased yields of April-planted cotton from 290 lb. per acre to 630 lb. and of May-planted crops from 360 to 490 lb. Results from June plantings are not yet available, but inspection of the crops in the field suggests that these will confirm the need for early planting to benefit from the use of insecticides and conversely, the need to use insecticides on early planted cotton. These district trials roused considerable interest among farmers and it was decided to encourage commercial distributors to market cotton insecticides in the province next season.

A trial was put down at Busia in Elgon Nyanza to compare the standard DDT spray (applications of three pints of 25 per cent DDT emulsifiable concentrate in eight gallons of water per acre) with the same weight of DDT in higher volumes and made up from wettable powders. The standard treatment produced the highest yield but differences were not statistically significant. Trials were planted at Kibos and Busia to determine whether the widespread practice of inter-planting beans in the cotton reduces cotton yields sufficiently to make the use of insecticides uneconomic. Inter-planting caused no reduction of cotton yields at Kibos and some increase at Busia. It would appear that provided both crops are planted early in the long rains there is sufficient soil moisture at that time for both. The use of insecticides is only economic on timely planted cotton with reasonable standards of soil fertility and cultivation.

Barley fly, (*Hylemyia arambourgi*): Large-scale trials were conducted on five farms in Rift Valley, testing aldrin, dieldrin and endrin dry seed dressings, and aldrin applied in a slurry with methyl cellulose. One farm failed to sustain an attack, whilst the barley on another was wiped out by *Helminthosporium teres*. On one of the remaining three farms good control was obtained with all four treatments, whilst on the other two endrin and aldrin appear less effective than dieldrin and aldrin plus methyl cellulose, although this difference was only well-marked with aldrin on one farm.

Aldrin, dieldrin, endrin, heptachlor, "Thiodan" and thiometon seed dressings were tested in a small experimental plot and heptachlor and dieldrin gave a high degree of control, whilst aldrin and endrin appeared less effective, and thiometon and Thiodan had no effect on the infestation.

Aldrin, gamma BHC and dieldrin with and without a phenylmercurial fungicide, were compared in a second experiment. No effect from the fungicide was found, but dieldrin was greatly superior to all other treatments whilst aldrin was better than gamma BHC.

In a further trial, aldrin wettable powder was mixed at three different rates with a phosphatic fertilizer and applied at the time of planting. No better control was obtained with these treatments than with the aldrin seed dressing.

A test of various methods of control showed a dieldrin spray applied three days after emergence of the coleoptile, to be superior to an aldrin seed dressing, an aldrin/fertilizer mixture and a dieldrin spray applied after an infestation had developed.

Sprays of various insecticides were applied to barley carrying a 25 per cent infestation and Phosphamidon and Rogor produced a decrease in infestation. The reduction was not considered sufficient to be economic, and it is apparent that any satisfactory control requires the elimination of the larvae prior to their entering the plants.

A test of dieldrin seed dressings, applied at different rates, showed that treatments as low as 2 oz. active ingredient per 100 lb. seed gave a fair measure of control but that 5 oz. active ingredient per 100 lb. was rather superior.

Pyrethrum thrips: A trial at the beginning of the year showed that thrips could be controlled with sprays of DDT or of dieldrin and that two applications at approximately a fortnight's interval were necessary. Three weeks after spraying a second time, the recorded population was still very low, but a heavy outbreak of a mite, Tetranychus ludeni, had occurred. A number of growers have also recorded heavy infestations soon after spraying against thrips and it is presumed that the use of persistent insecticides has resulted in the elimination of agents controlling the mites. A trail was put down using schradan and chlorobenzilate, but counts one and three weeks after treatment failed to show any reduction in population. The schradan treatment was observed to have greatly reduced the residual thrips population.

In a further experiment on control of thrips, malathion was shown to have no effect on the population, whilst Rogor gave some reduction in numbers but could not be regarded as efficient. Endrin with two applications was effective as DDT.

Nematocerus sp.: Severe damage was caused to barley and wheat in the Naro Moru and Moyo Ridge areas. Two isolated cases of damage were also recorded in the Uasin Gishu and Trans Nzoia. Insecticides have so far had little effect. A trial on oats, intended for chafer control, involving seed dressings of dieldrin (2.5 oz. a.i. per 100 lb.), aldrin and gamma BHC was completely destroyed by Nematocerus, whilst plots in an observation trial, using lead arsenate, Sevin and gamma BHC were also destroyed. Three insecticides, dieldrin (8 oz. a.i. per 100 lb. seed), heptachlor and thiometon, gave some control but cannot be considered very effective.

No experiments have been possible on cultural control, but observations show that where a crop has been completely destroyed no attack occurs on the next season's planting, whereas land which has carried a medium or light infestation in one season is heavily attacked in the next. It has therefore been suggested to farmers that a rule of one crop per annum off any one field should help to achieve control. In addition, crops planted two to three weeks before the onset of the rains appear to be sufficiently well grown to withstand an attack which does not occur until just after the rains begin.

Coffee pests: Leaf miner, (Leucoptera meyricki Ghes. and L. caffeina Washb.) attacks were widespread and severe, especially in the latter half of the year. By the end of December, however, the parasite complex was generally in control in all areas except Upper Kiambu, Malathion was used to control adult moths, parathion or diazinon to control the larvae in the mines. In trials to find a new larvicide which is cheaper than diazinon and safer than parathion, "Rogor" and the Murphy insecticides M.C.7 and M.C.47 showed some promise, but further tests are required. "Metasystox" and "Phosphamidon" were disappointing. A spray containing 0.01 per cent pyrethrins killed L. meyricki eggs in the laboratory and further work on this line, in co-operation with the Pyrethrum Board of Kenya, was initiated. In a survey in the last quarter of the year at Ruiru, leaf miner damage was shown to be the most important cause of premature leaf fall. In unshaded, somewhat droughted coffee, a single small mine was sufficient to cause abscission.

The tip stem borer, Eucosma nereidopa Meyr., caused serious damage to suckers on estates in Upper Kiambu which were in the early stages of a multiple stem-pruning cycle. Biological studies have shown that the points in the life history of this pest where it is most susceptible to sprays are - (a) the adult moth, which spends daylight hours chiefly on the trunks of shade and coffee trees; (b) the mature caterpillar which leaves the suckers to pupate on the coffee tree trunks. Laboratory work was directed to finding suitable persistent insecticides to spray on to the bark to kill either or both of these stages. A number of insecticides show promise and field trials will begin early in 1959.

The berry moth, Thliptoceras octoguttale Feld., caused severe damage on estates in the Makuyu-Thika area. Effective control probably depends on spraying when the berries are in the pin-head stage. No attack was reported, however, until destruction of the berry clusters was nearly complete. A trial of 11 insecticides was put down at Makuyu.

Leaf-eating caterpillars were generally less troublesome than in 1957, the skeletonizer, Epiplema dohertyi Warr., causing most damage. Lead arsenate is recommended for controlling these pests.

Field trials with various pyrethrum formulations against antestia bugs, Antestiopsis spp., gave disappointing results despite the fact that the concentration of pyrethrins used was much greater than is necessary to kill antestia in the laboratory. Experiments designed to throw some light on this discrepancy were started at the end of the year. A test spraying of malathion by aircraft proved successful. The results obtained and recommendations regarding concentrations were published in the Coffee Board Bulletin of April, 1958.

The lace bug, *Habrochila ghesquierei* Schout, had extended its range to Makuyu and Thika by the end of the year. Some planters found it necessary to spray malathion or parathion, but on most estates the mirid predator, *Stethoconus* sp., kept the pest in check.

There were a number of severe attacks of the mealybug, *Planococcus kenyae* (Le Pelley), in the Makuvu area despite the absence of attendant ants. Spot spraying the suckers with diazinon gave reasonably good control. A few adults of the parasite *Allotropa* sp. were recovered from some Uganda mealybug material. Despite careful treatment, however, they could not be induced to reproduce in the insectary.

Heavy infestations of the brown scale, *Saissetia coffeae*, and the white waxy scale, *Ceroplastes luteolus* De Lotto, occurred on some estates. Fortunately, these scales cause far less damage than an equal number of green scales (*Coccus* spp.). On most plantations the infestation was cleared up by parasites and predators without the trees receiving more than a temporary set-back. None of the sprays used killed anything except the smaller nymphs. The bark scale, *Asterolecanium coffeae* Newst., appears to be increasing in severity in low altitude coffee. Five per cent tar oil gave 100 per cent kill of eggs in the laboratory but was very disappointing when tried in the field.

The control measures devised in Tanganyika, namely spraying 18 in. of the trunk with ½ per cent dieldrin, which have been proved effective in Kenya, were used in a campaign for the control of the white borer, *Anthores leuconotus* Pasc., in the Makuyu-Mitubiri area. All trees more than three years old were treated in March and again in October.

Distortion of young leaves and the formation of corky patches in their undersides is usually attributed to mite damage since the symptoms resemble those described by Tapley on Tanganyika coffee (E. Afr. agric. J. (1953), 18, 191-192). The only phytophagous mite found to date, in any numbers, on Kenya coffee is a red phytoptipalpid, probably *Brevipalpus phoenicis* (Geijskes). This species was caught in large numbers on leaves of various ages but no distortion or suberization resulted.

Tomato, blight control: Four proprietary fungicides were tested for their efficiency against tomato blight (*P. infestans*). Tomatoes, variety Hundredfold, were planted at a spacing 6 ft. by 3 ft. by 2 ft. on 25th April, 1958. The design was randomized block with four replicates; each replicate consisting of 40 plants. Due to a delay in receiving "Kaptan" the whole trial was sprayed with "Blitox" until 3rd June, 1958. Seventeen applications were made at weekly intervals using the recommended concentration of each material. The treatments were applied with a stirrup pump and handlance at the rate of 400 gallons of wash per acre. The results are given in the following table.

Material	% Concentration	Total Yield Tons/Acre	% Diseased Fruit
Dufox	0.3	15.0	0.20
Kaptan	0.2	13.7	0.32
Blitox	0.3	10.1	0.87
Zineb	0.3	16.0	0.17
Control	-	4.6	35.30

All materials gave a significant increase in yield over the control. "Dufox" and zineb gave a significant increase ($P = .05$) over "Blitox", but "Dufox" could not be recommended for commercial use on tomatoes owing to its mercury content.

(Department of Agriculture, Annual Report 1958, Vol. II - Record of Investigations.)

MAURITIUS

Sugar cane

Nematode control trial: Experiments with the soil fumigant EDB (ethylene dibromide) were pursued with some interesting results. In 1958, six simple preliminary experiments were made in different localities, each consisting of small plots in which the soil was treated with EDB before planting using hand injector guns. Treatments were not replicated, there being usually two treated plots with an untreated plot between them. The results were assessed by vigour of early growth and by yield of cane at harvest. In all but one of the experiments tillering and early growth of shoots was considerably better in the treated plots and yield of cane was increased by the equivalent of several tons of cane per arpent* as shown below. Following this, three further trials with EDB have been laid down. Two of these are on sandy soil and one on gravelly soil and an effort is being made to follow not only differences of cane growth after treatment but also changes which occur in the nematode soil fauna. Early data from one of the trials on sandy soil indicate that the population of free-living Tylenchoid nematodes is reduced for a period of months after soil treatment and is accompanied by an increase in the numbers of certain "saprophagous" forms.

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* 1 arpent ≡ 1.043 acres.

Cane yields (tons/arp.) following pre-planting soil fumigation with ethylene dibromide

	Untreated	Treated	% Increase
Mont Choisy (sandy soil)	14.2	19.0	34
" "	17.9	23.3	30
Union Park	32.0	36.8	15
" "	21.3	25.6	20
Bel Etang	30.0	35.1	17
Belle Rive	26.4	25.2	-

White grub, Clemora smithi: Experiments with insecticides, the progress of which has been described in earlier reports, have the object of finding a simple and cheap method of preventing infestation in places where the insect continues to be of concern.

Chlordane and aldrin have proved to be highly efficacious against *Clemora* and additional data obtained in 1959 serve only to supplement those given in the Annual Report for 1958. In brief, chlordane at 2-8 lb/arp. and aldrin at 2-4 lb/arp. distributed in the furrows at planting in liquid or dust formulations give good grub control for 2-3 years. When applied to the soil surface adjacent to rows of ratoon cane, grub control is less and is erratic at the lower dosage rates.

The efficacy of the insecticides against the grub when applied to the furrows is considered to have been amply demonstrated but yield responses have been inconsistent and difficult to interpret. When applied to ratoon cane, however, it is now concluded that even the lower doses of emulsions depress growth. Furthermore, a trial made in 1958 with aldrin in powder form applied at 1, 2, and 4 lb/arp. along rows of ratoon cane and earthed over resulted in significant yield reductions of several tons of cane per arpent from each treatment. It is concluded that the use of these insecticides in a manner which is both effective and safe has still to be demonstrated and it is advisable for planters to refrain from use of these chemicals pending final results from experiments. Two new trials with a larger plot size than previously used were laid down during the year and test applications are to be made in estate plantings on different soil types and climatic areas.

There follows a summary of results obtained in other countries.

(Mauritius Sugar Industry Research Insitutue, Annual Report 1959.)

NORTHERN RHODESIA

Agriculture:

The disease situation on plants in general followed its usual pattern of development with insect pests prominent at the beginning of the rains and fungous and other diseases more conspicuous as the season advanced. A severe yellowing of maize associated with slow growth in times of heavy rains was widespread in parts of the Central Province (including Mount Makulu) and was noticeably like the disease associated with zinc deficiency in parts of South Africa; it is being further investigated. Corn root-worm of maize appears to be on the increase and this season it was reported not only from the Southern Province, where it was first noted several years ago, but from the Central Province also. Maize streak virus was again widespread. In Turkish tobacco frogeye (*Cercospora*) was the most serious disease of the year but anthracnose (*Colletotrichum*) was present as a disease in fields as well as in seedbeds, while rosette was unusually abundant and mildew was locally serious.

Green scale is the most persistent and widespread pest of coffee, but a white oil plus dieldrin spray for which the growers are charged 2d. per tree is now giving good control.

An outbreak of wildfire disease, (*Pseudomonas tabacum*) on tobacco was brought under control by spraying with 'Agromycin 100'.

With regard to plant breeding trials *Phaseolus* beans yielded in the range of 400-600 lb. per acre, being much affected by bean-fly except for the type Nanziande where a yield of over 900 lb. per acre indicates that the bean-fly might jib at this possibly unpalatable variety. *Cerospora* leafspot on the susceptible varieties of groundnuts again proved amenable to control by such fungicides as zineb and maneb in particular with a consequent marked increase, as much as 750 lb. per acre kernels. Fungicide application on a variety more tolerant of leaf-spot gave no significant increase in yield. The use of fungicides has improved the yield of comparatively resistant as well as *Helminthosporium* susceptible summer varieties of wheat and further tests will be made. Stem-rust was unimportant on summer wheat (*Helminthosporium* is much more to be feared) but on wheat sown on seepage sites between the season of summer-wheat and winter-wheat was severe enough in conjunction with bird damage to lead to disappointing yields of about four bags to the acre.

(Annual Report of the Department of Agriculture for the Year 1959.)

Groundnuts - Pests and Diseases: Groundnuts are not, on the whole, subject to attacks by many highly specific pests. Termites and chafer larvae or "white grubs", as they are locally known, attack the root system of groundnuts on occasions, causing wilting. Attacked plants may recover to a certain extent, but usually the harvested produce is shrivelled and of low quality. Termites also attack the aerial parts of developing and mature plants causing them to disintegrate, leaving many pods in the soil. The surface of pods and sometimes kernels are eaten.

Attack by caterpillars occasionally causes extensive defoliation. In most seasons there is some damage of little significance.

An apical yellowing of leaflets has been observed locally. This is similar in appearance to the hopper burn reported from the United States, caused by jassids of the genus Empoasca. It seems probable that this damage may have a similar cause in Northern Rhodesia.

Aphis craccivora is probably the most important insect attacking groundnuts as it is the vector of the rosette virus. The groundnut plant is not one of the most favoured hosts and large colonies are only occasionally seen on groundnuts in Northern Rhodesia. Other legumes, especially beans, are usually more heavily infested. Direct damage is slight but by transmitting the rosette virus this aphid may bring about severe losses on occasions.

The commonest and most serious form of virus encountered in the Territory is that commonly called "yellow rosette". The symptoms of this are severe stunting of the plant, together with chlorosis and distortion of the leaves. The depression of yield depends on the stage at which infection occurs. Early infections result in complete loss of crop; later infections produce successively less severe depressions of yield.

It has been found that satisfactory control of the rosette virus can be achieved by early planting and the establishment of good stands. Serious epidemics so far have only been encountered in places where conditions generally have been unsatisfactory. The usual form taken is of isolated patches of varying size throughout the field.

A disease causing more consistent and widespread damage is leafspot. Two fungi, Cercospora arachidicola and C. personata, have been found to cause leafspot in Northern Rhodesia. In the more susceptible varieties the leaflets die some time after the first lesions appear on the leaf and are shed. The lesions usually take the form of circular brown spots on the leaf surface which may have a yellow halo. Many lesions may occur on a single leaflet and as the season advances they may also be found on the petioles and stems of the more susceptible varieties.

Losses of up to 50 per cent of yield in the most susceptible varieties have been recorded in experiments on leafspot control in Northern Rhodesia. Fortunately most of the varieties grown by Africans are fairly resistant to the disease. Leafspot has been effectively controlled by rotational practices and early planting. Early planting enables the crop to make progress before the build-up of high inoculum potentials occurs. The separation of successive sites of groundnut cropping by as great a distance as possible would also serve to delay infection more particularly if windbreaks were present between the two sites, preventing the carry over of wind-borne spores.

The control of seedling and pre-emergency rots by means of seed-dressings is a routine practice with some of the more progressive farmers. At the present time, however, most of the groundnut kernels used for seed have been hand shelled with the result that little trouble from these diseases is experienced. If the use of machine shellers becomes popular, seed dressing may then be essential. The sulphur based T.M.T.D. seed dressings are replacing the original organo-mercurials used, as the former controls Aspergillus niger, the cause of crown rot, a disease which has been recorded for the Territory.

The fungus, Sclerotium rolfsii, can attack most parts of the groundnut plant. It causes a thread blight of leaves and a basal stem rot in Northern Rhodesia, and it has also been recorded attacking pegs and pods. A blue discolouration of kernels is frequently observed which is reported to be produced by the action of this fungus. Metabolic products of the fungus present in the shell have been found to diffuse towards the kernels producing this discolouration known as "blue damage". Rapid curing of pods is regarded as the best method of control in America.

A more serious form of curing damage is "concealed damage", reported from the United States and also known in Northern Rhodesia. This is a more serious form of damage in that the oil stored in the cotyledons of the embryo becomes rancid, whereas in "blue damage" the embryo is unaffected. Rapid curing is the recommended control in the United States. The local practice of shelling groundnuts soon after harvest renders the incidence of these two forms of curing damage low; when unshelled pods are kept for any appreciable length of time the damage becomes more serious.

Bacterial wilt, Pseudomonas solanacearum, occurs on groundnuts locally but is seldom responsible for large scale losses. It is sometimes more noticeable on newly cultivated land than on land which has been in cultivation, especially to cereal crops.

On the grounds of cost, control measures for diseases must be based as far as possible on husbandry practices. Effective control of most groundnut diseases can be achieved in this way or at very low cost by seed dressings.

(Extract from Rhodesia Agricultural Journal, January-February 1960 57 (1), 70-71 "Groundnuts in Northern Rhodesia". J. Smartt.)

Potato pests: insecticidal control

Tuber moth, (Gnorimoschema operculella): Most damage by the tuber moth is likely to be experienced in crops planted from July to November. These crops should be sprayed when the plants are 6 to 12 in. high and again 14 days later. DDT at the rate of 3 lb. of 50 per cent wettable powder in 100 gallons of water or five pints of 25 per cent emulsion in 20 to 100 gallons of water is the insecticide normally used, but dieldrin, endrin and malathion will also control the potato tuber moth. The spray should be applied to give a good overall cover to the plants.

Stored potatoes, including seed potatoes, are protected from tuber moth attack by thorough treatment with 2-2½ per cent DDT dust applied at the rate of 4-6 oz. to 150 lb. of tubers. An alternative method is to store the tubers in bags that have dried after being dipped in a two per cent DDT emulsion.

Leaf-eating ladybird, (Epilachna canina): Damage is usually first noticed at the end of October soon after the adult beetles have emerged from their winter hibernation and is, of course, most serious when the infested plants are small.

The leaf-eating ladybird may be controlled with sprays or dusts containing malathion, dieldrin, or endrin. The amounts of actual insecticide applied per acre are ¾ lb. malathion, ½ lb. dieldrin or ¼ lb. endrin. DDT applied at 1 lb. an acre gives some control but is not as effective as endrin or malathion.

Aphids: Those commonly infesting potatoes are Myzus persicae and Macrosiphum euphorbiae. Aphids on potatoes may be controlled by sprays containing DDT, malathion, parathion or nicotine and spraying should be undertaken as soon as colonies are detected on the plants. The spray should be directed to the underside of the leaves, particularly the lower leaves, where many of the aphids may be located. To give adequate cover to the plants, about 100 gallons of water should be applied per acre, or smaller quantities if special low volume sprayers are used, the quantity of insecticide applied per acre being 3½ pints of DDT 25 per cent emulsion, 2 lb. of DDT 50 per cent wettable powder, two pints of malathion 50 per cent emulsion, 2 lb. of malathion 25 percent wettable powder, 8 oz. of parathion 25 per cent wettable powder or 1½ pints of 40 per cent nicotine sulphate.

If insecticides are applied when the plants are young and spraying is repeated at 7-10 day intervals until the plants are well-grown, the spread of leaf-roll virus can be considerably reduced. Unfortunately, no insecticides are presently available to kill the aphids quickly enough to prevent them spreading virus Y.

Leaf hopper, (Empoasca fascialis): Leaf hoppers are rarely of major importance on potatoes in Southern Rhodesia. They may be controlled by DDT spray or dusts; five per cent dusts should be applied at 20 lb. an acre when the plants are small and up to 40 lb. an acre as they grow larger. Sprays should be made with 3½ pints of DDT 25 per cent emulsion or 2 lb. of DDT 50 per cent wettable powder, between 60 and 120 gallons of water being applied per acre, depending on the size of the plants. Dieldrin, parathion and malathion as applied for the control of other potato pests are effective in the control of leaf hoppers.

Cutworms, (Agrotis spp.): The usual methods of control for cutworms is to apply a band of dust or spray to the soil along the rows of plants. DDT and dieldrin are effective, and aldrin may be used if harrowed into the soil after applying. Poison baits are effective if the soil surface is moist when applied. The bait is prepared by mixing 1 lb. of either sodium fluosilicate or paris green (both poisonous!) with 25 lb. of dry bran and moistening with about three gallons of water. The bait should be broadcast evenly and thinly over the infested area at 15 to 20 lb. an acre, preferably in the late afternoon.

(From Potato Production (VIII) Pests. C. E. Taylor & G. C. Martin. Rhodesia Agricultural Journal, January-February 1960, 57 (1) 60-63.)

NYASALAND

Cotton pest research

The basic investigations into the biology and control of the cotton bollworms, together with toxicological work, continue to be carried out at the Gatooma Research Station, while investigations into the biology of cotton stainers continue at the Makanga Experiment Station.

Insecticide trials, together with associated biological studies based on the work at Gatooma have been extended to the Chitala Experiment Station, Central Province, Nyasaland, and to the Sabi Valley Experiment Station, Southern Rhodesia.

Biological investigations: Considerable data on the life history of *Diparopsis* has been obtained, which will be of great value for the development of control measures.

Egg mortality has been shown to be extremely high at certain times. Under field conditions the incubation period is 6-13 days although the time of hatching remained between 04.00-08.00 hours.

The 1st instar larvae wander for a sufficiently long period before penetrating the plant to be exposed to insecticide deposits for a reasonable period. During development larvae have been shown: to construct a protective cell at the site of penetration; exhibit "re-entry" movement, and transfer to fresh food; and when fully developed to drop from the plant and move away to pupate.

Mortality, caused by ants, including *Pheidole megacephala* F. was of considerable importance at all stages in the life cycle.

Pupation experiments have shown the importance of early build-up of *Diparopsis* infestations if cotton is rattooned. Overwintering pupae formed in increasing numbers towards the end of the season give rise to moths from October to March the following season, with a small proportion carrying over to a further season. Pupal development at 75-85°F gives rise to moths over a period of twenty weeks. Depth of pupation affects the date at which moth emergence commences without affecting the length of the emergence period.

Chemical control tests:

Toxicity: *Diparopsis* eggs laid on muslin, incubated at 75°F at which temperature they hatch after 6 days, have been dipped into various concentrations of insecticides, when 5 days old. No insecticide tested has prevented the development of the egg, but as the 1st instar larvae eats its way out of the egg, it can be killed before it leaves the egg shell.

Individual buds have been sprayed to "run off" and individually infested with a single *Diparopsis* egg. The toxicity of the insecticide is evaluated by the number of 1st instar larvae which penetrate the bud. Initial results with this technique indicate that the relative toxicity is comparable with the egg dipping technique.

Results to date indicate that "Sevin" is very toxic to the 1st instar larvae of Diparopsis.

Toxicity tests with Heliothis have been commenced, and indicate that DDT is more toxic than "Sevin".

Persistence: Single rows were sprayed to "run off" and the persistence assessed by the percentage penetration of sample buds individually infested with Diparopsis eggs. All the insecticides persisted fairly well until it rained. The DDT emulsion was the most persistent as shown below.

Percentage penetration of buds at intervals following spray application - corrected for control mortality on unsprayed buds

Insecticide	% Concentration of spray	Sample collected - days following spray				
		0	2	4	7	10
Endrin emulsion	0.50	0	0	16.7	52.5	23.3
" "	0.25	0	16.7	30.8	90.0	85.0
Sevin wettable powder	1.00	0	0	0	7.5	38.6
" " "	0.50	0	0	0	15.0	46.4
DDT emulsion	1.00	0	0	0	15.8	7.8
Progressive rainfall total	-	0"	0"	0"	0.77"	0.99"

Field trials: Details are given of various control programmes against Diparopsis, Heliothis and Earias and Dysdercus. The farm scale insecticidal trial was continued with four sprayed and four unsprayed plots each of three acres, arranged in pairs; each pair situated on a farm in the Gatooma district. One pair of plots followed pigeon pea and the other plots, except one (following wheat), followed maize; all plots received fertilizer applications. Plots 6, 8 and 12 received 8 applications of endrin at the rate of $\frac{1}{4}$ lb. active ingredient in 10 gal. of water per acre at weekly intervals from first buds using a Leo-Colibri No. 9 pressure retaining knapsack sprayer giving a constant pressure of 50 lb. per sq. in. Plot 10 received only 5 applications at fortnightly intervals. The nozzles were changed from D2 Hollow Cone Discs to Conejet Y6 tips as a result of spray coverage tests. The sprayed plots were situated at least one mile from the unsprayed plots, and from each plot records of plant growth and insect populations were taken at fortnightly intervals from four sampling areas. The Diparopsis population was generally higher than the previous season, but despite this the plants were able to set a reasonably good crop during the early part of the flowering period. The live overwintering population at the end of the season was higher than in 1958, although considerable mortality had occurred on most plots.

A heavy Heliothis attack occurred on the sprayed plots during the peak flowering period, and was not effectively controlled by the endrin spraying. Earias and Dysdercus populations were again low.

Maximum shedding coincided with the Heliothis attack, and rather more of the sheds on the sprayed plots were damaged by bollworm than on the unsprayed.

In a comparative field trial the insecticides endrin, "Sevin" and DDT were applied eight times during a period of nine weeks in a randomized block experiment with five replications.

The yield of the DDT treatment was significantly higher than the yields of the three endrin treatments and the two Sevin wettable powder treatments. The lower yield from a "Sevin" treatment was significantly less than any of the three endrin treatments. There were no significant differences within the different endrin or Sevin treatments. The entomological data suggests that these yield differences were caused by differences in the efficiency of the sprays in controlling Heliothis attack, which was the main cause of loss of yield. It is also apparent that Sevin gives a better control of Diparopsis than either endrin or DDT, the last being least efficient in control of this pest.

To determine whether complete control of Heliothis could be obtained some cotton which had already received 7 applications of endrin was sprayed to "run-off". Heliothis larval counts at intervals before and after spraying showed that even when heavily applied endrin did not give complete control. Increasing the number of applications from seven to twelve, even at low volume, resulted in a substantial increase in yield.

Other field trials: DDT, DDT + BHC and "Sevin" dusts were applied by means of an airblast knapsack unit, to cotton infested with Heliothis. Applications of 15-20 lb. of 5 per cent DDT or 5 per cent Sevin dust resulted in approximately 80 per cent reduction in the Heliothis larval population. Endrin, dieldrin, "Sevin" and DDT were applied at various rates to cotton infested with Dysdercus. Owing to stainer movement between plots and from outside the trial, none of the treatments completely cleared the plants of stainers. Sevin and DDT applied at 1 lb. active ingredient per acre or endrin and dieldrin at $\frac{1}{2}$ lb. a.i.p.a. gave better control than at lower rates of application.

Cotton yields: Cotton yields were extremely good in the Lower River, despite late planting rains. Cotton stainer populations built up too late in the season to cause any considerable damage. The Sterculia eradication experiment indicated that the stainer population during the critical March-April period was lower in the centre of the area cleared of Sterculia trees for the 1958/59 season.

Platyedra gossypiella Saund. was recorded for the first time in Southern Rhodesia on cotton and Hibiscus dongolensis.

Maize stalk borer

Investigations: Investigations into the control and biology of the Maize Stalk Borer (Busseola fusca Hmps and Chilo zonellus Swinh) have again been the Entomologist's major field of work. The technique of dusting young maize plants 18 in. high and using a tin with four holes punched in the base with a 1 in. nail has now been successfully carried out by African cultivators themselves on demonstration strips in their gardens. Attacks may be expected to be worst when maize is planted after the first soaking rainstorms and when these are followed by steady rains within 2-3 weeks. There is some evidence to suggest that nitrogen application will cause heavier attack.

Experiments over the past two seasons have shown that such attacks can easily and economically be controlled by an application of 10 lb/acre of 10 per cent DDT dust, shaken into the funnel of the maize plant when it is 18 in. high. When the rains are early and the emergence period may be expected to be prolonged there would appear to be some advantage in splitting the application into two dressings 14 days apart.

(Annual Report of the Department of Agriculture for the Year 1958/9 (Part II)

SINGAPORE

Mosquito control: No case of malaria of indigenous origin was reported during the year, Singapore continues to enjoy freedom from malaria but only as a result of constant vigilance on the part of the Health Department. The island of Singapore is congenial for the breeding of dangerous malarial vectors, and therefore potentially malarious.

It is necessary to maintain strict Aedes control around the International Airport as Singapore is a yellow fever receptive area. A special health team ensures control within the area 880 metres from the airport perimeter fence; control in maintained by residual spraying, swing fogging, clearing of secondary vegetation and the filling of tree holes and bamboo stumps. Rigorous surveys ensure that the control is being carried out satisfactorily. Aedes aegypti index was nil on each of the four major surveys carried out. The Aedes albopictus index is now 1.56 per cent. In November 1954 the Aedes aegypti index was 6 per cent and Aedes albopictus index 33 per cent.

(Annual Report 1958.)

SWAZILAND

Malaria: The malaria position has remained very satisfactory. During the 1958-59 transmission season control measures were restricted to the irrigation schemes and large farming estates in the eastern lowveld areas, where there is a considerable turn-over of labour, much of which comes from Mozambique, where malaria control measures have unfortunately not yet been instituted. The rest of the previously malarious area was covered by surveillance teams, whose duties consisted of the taking of blood slides from children, from all cases of febrile illness encountered, and from all immigrants found, and the "dosing" of the latter with chloroquin and daraprim; the submission of mosquito larvae for identification; the test-spraying of huts for the presence of mosquitos; assistance with night-catches of mosquitos; and the follow-up and dosing of all cases giving positive slides. During the season 15,682 blood slides were examined, which is more than twice the number examined in previous years, and of these 165 were positive for malaria parasites, but 135 of these "positives" were immigrants from Mozambique. During the same period, 12,785 huts were test-sprayed, and only 65 Anopheles gambiae mosquitos were found in the huts, and 40 of these were from an isolated group of 8 huts near the Mozambique border which had escaped previous control measures. Night catches confirmed the previous findings that the Anopheles gambiae mosquito in Swaziland is now chiefly exophilic and zoophilic. In 16 night-catches, 5 Anopheles gambiae were caught biting man outside (and this at two "catches" where there were no cattle in the neighbourhood), whereas 108 Anopheles gambiae were caught biting cattle and 144 were caught resting in cattle kraals. No Anopheles gambiae were caught in huts. A W.H.O. Malaria Assessment Team paid a short visit to Swaziland in December.

Bilharziasis: Work on this disease was again confined to surveys, no major control measures being instituted on account of the comparative ineffectiveness of present control measures in conditions such as exist in Swaziland.

Investigations into the incidence of the disease in the various age groups and of the snail population were carried out throughout the year and the whole Territory, except a small area in the south-west, has now been fairly well covered.

The position revealed is very much as expected, namely that in most areas of the middleveld and bushveld there is an incidence of between 20% and 40% of urinary bilharzia, with little intestinal bilharzia, except in the north-east of the Territory, where the incidence of the latter may go up to 40%, and consequently, as previously stated, all rivers, streams and dams in the middleveld and bushveld must be considered as possible sources of bilharzial infection.

Ii However, a striking result was obtained in the survey at Sipofaneni, in the bushveld, where an incidence of 30% infection with urinary bilharzia might have been expected. The survey, in fact, revealed no urinary bilharzia, and this is thought to be connected with the fact that the people surveyed use the hot springs in the neighbourhood for bathing, and the fast-flowing Usutu River for the washing of clothes.

The number of cases of bilharzia seen at Government and Mission hospitals during the year was considerably higher than in the previous year, namely 739 (734 of the urinary type and 5 of the intestinal type), as against 543 in 1958. Again the great majority of cases were small boys complaining of haematuria and few of the late and serious effects of the disease were seen. The significance of this rise in the number of cases reporting for treatment is not clear, but there has been a considerable variation in the number of cases reported year by year over the past 10 years, the range being 719 to 298.

Mzimnene Catchment Area: The Snail Control Pilot Project in the Mzimnene catchment area was abandoned at the end of 1958. It was clearly shown that the application of copper sulphate, though it reduced the snail population, did not have any effect on the transmission of the disease which remained at a level equal to that pertaining prior to the commencement of the molluscicide application. Later, control measures were re-introduced using a new technique - one of broadcasting, onto the water and among the water weeds, a mixture consisting of copper sulphate and sand. Results were most unsatisfactory and the project was abandoned. No further experiments are proposed until a more satisfactory molluscicide is available.

(Annual Medical and Sanitary Report for the Year 1959.)

TONGA

Agriculture

During May a sudden outbreak of "army worm", caused some alarm in a comparatively small area between Tokomololo and 'Utulau villages. The species concerned was *Spodoptera maurites*. Boisd and the main damage was to grass although a few kumala gardens were attacked. Dusting with 2% DDT had some effect but by mid June the caterpillars had pupated and that was the end of them. Parasitism was extremely heavy and although not as heavy as in a later outbreak of hawk moth caterpillars on the Farm, where it appeared to be almost 100%, no further damage was reported. The hawk moth larvae completely defoliated about two acres of kumala but heavy spraying with arsenate of lead saved the rest of the crop. Of 22 larvae put into breeding cages 21 were found to be parasitised in larval or pupal stage.

Banana scab moth: Treatment with 2% DDT dust has been continued throughout the year and the fruit has remained free from scab moth damage.

Rodent control: Every year rats account for several thousand pounds worth of damage in Tonga and Vava'u islands alone. The loss in copra, based on figures obtained from investigations made on the Vava'u Farm, amounts annually to some £25,000 and in Tongatapu to very much more. Damage in houses is becoming increasingly serious and as a potential carrier of disease the rat is always a menace. A campaign, to exterminate rats on quite a small scale to begin with, has been started. A proprietary rat poison named "Sorexa" is being used, with excellent results to date, and one man has been detailed to the work of laying and renewing the poison. So far only houses and stores in Nuku'alofa have been tackled but it is intended that the work shall be extended to plantations in 1959. The poison, a grey powder, is mixed with nineteen parts, by volume, of rice bran and then sufficient molasses, diluted to easy pouring consistency with water, is added to the mixture so that it is just damp, forming into a ball when squeezed in the hand but crumbling when pressure is removed. Rats take this readily and several houses and stores have been completely cleared already. At first rice bran only was used with the poison but it was soon found that the addition of a small amount of molasses made the bait very much more attractive to the rats. Issue of the mixture direct to householders and storekeepers was tried initially but had to be discontinued. Bait was put in the wrong places, allowed to get wet and go mouldy without being replaced, or it would be finished up and no more put down for some days. In the end it was decided that this was a waste of material and so the work is done now by an employee of the Department and he mixes the bait, lays it and replenishes it as necessary. When he has obtained a little more experience he will carry out some work on rat extermination in plantations and we shall then try some really large scale work on rat control.

Hornets: A 2% "Kadol" spray applied with 3-gallon knapsack sprayer has proved very effective in the control of the hornets and of their nests. The same spray of similar strength has been used by the Tonga Copra Board for the control of copra bugs in the sheds.

(Report of the Agricultural Department for the Year 1958.)

Mosquito and Fly Control: This work was carried out mainly in Tongatapu and Niuatoputapu using labourers and a solution of DDT 5% in oil for the spraying of swamps, water pools and pit latrines. In Niuatoputapu, in addition to spraying, an area about 100 yards wide all round the villages was cleared of bush and undergrowth and planted with root crops. On this island, previously heavily infested with mosquitoes, these anti-mosquito measures were highly successful in reducing the density of mosquitoes and the incidence of filarial attacks amongst the residents. Over 300 pounds of DDT powder in 792 gallons of oil were used for the spraying of about 107 acres of water surfaces and 4038 pit latrines.

(Report of the Minister of Health for the Year 1958.)

TRINIDAD AND TOBAGO

Forest Protection: The chief cause of insect damage was the bachac or parasol ant (*Atta* sp.). This leaf cutting ant attacks several species e.g. mahogany (*Swietenia macrophylla*), pink poui (*Tabebuia pentaphylla*) and in some cases teak. The shoot borer (*Hypsipyla grandella*) of mahogany, cedar (*Cedrela mexicana*) and crappo (*Carapa guianensis*) caused some damage in plantations of cedar but provided the affected trees were in vigorous condition the damage was soon thrown off. The mahogany canker, whose causal organism has not yet been identified, became apparent on trees of two or three years old which had regenerated naturally under a parent stand of mahogany.

(Administrative Report of the Forest Department for the Year 1957.)

UGANDA

Tsetse control - general: The Report Year for the department was changed to coincide with the financial year from July to June. This report covers therefore the eighteen-month period from January 1958 to June 1959.

By the end of 1957 more than 7,000 sq. miles of the country newly invaded by *G. morsitans* and *G. pallidipes* in central and northern Uganda during the 1930's and early 1940's had been fully reclaimed from these savannah tsetses - chiefly by use of the game elimination method. During the period under review work was continued on the final phase of these major tsetse control operations in Bunyoro, Lango, Acholi and Karamoja districts.

It became necessary also to devote a much larger proportion of the departmental effort than in earlier years to the Ankole *G. morsitans* belt of south-western Uganda. This was because it became quite clear early in the period under review that continued application of the East African Trypanosomiasis Research Organisation's intensified programme of discriminative bush-clearing was not likely to deal effectively with this most serious and steadily expanding problem. The outcome of a very careful re-appraisal of the problem by all concerned was a decision reached in March 1958, that the demands of the immediate situation could only be met by abandoning further bush-clearing and resorting as quickly as possible to the method of game elimination. Owing to the fact that Nyabushozi County of Ankole is a valuable game area it was agreed that tsetse control hunting should be restricted, at least in the first instance, to the primary objective of preventing further spread of G. morsitans; and that further investigational work should meanwhile by pursued with the object of finding a more acceptable alternative method of reclaiming the "heart" of the fly-belt.

Hunting started in north-east Ankole on 1st July 1958. By the end of the period under review, i.e. after the first twelve months of hunting, there appeared to be good grounds for believing that further eastward spread of G. morsitans had been successfully halted. As regards further north-eastwards and northwards spread, however, the position remained uncertain. There was also good evidence from some internal parts of the hunting zone that an appreciable decrease in fly densities had already been brought about.

As a possible alternative to hunting, the application of residual insecticide to the vegetation of the Ankole-type concentration areas of G. morsitans was tried out, by the Colonial Pesticides Research Unit, in a small isolated G. morsitans belt in a valley in south Ankole. The results of this trial, though not quite conclusive, were sufficiently promising to indicate that the reclamation of the heart of the Nyabushozi G. morsitans belt might be achieved by this means.

While Ankole presented much the most serious tsetse problem during 1958/59 this was regrettably not the only part of Uganda in which some tsetse control setback was experienced. Although no serious extensions of fly-belts appeared to have occurred elsewhere, there were undoubtedly more tsetses present in some of the residual reclamation areas than were there in 1957. Observations of appreciably increased G. morsitans densities were made, in particular, in both the Maruzi, Lango, and north Karamoja operational areas. No direct cause of such increases could be determined; but since similar increases have been noted in several other parts of Africa in recent years, e.g. in South Rhodesia and Northern Nigeria, it appears that they may have been part of a general upward surge in the well known but as yet little understood "long-term cycle" of tsetse numbers.

Whatever their causes, these increases in tsetse numbers made 1958/59 an unusually difficult period for tsetse control. In both Maruzi, Lango and north Karamoja the rises in G. morsitans densities began at very approximately the same time, in the August-October period of 1958. By the end of the report period, in June 1959, it was quite clear that the levels of tsetse density in both areas were still appreciably higher than they had been a year or even two years earlier.

Despite the setbacks in such areas as Nyabushozi (Ankole), Maruzi (Lango) and north Karamoja further solid progress was achieved in many directions. Insecticidal operations, against G. palpalis in north Lango and West Nile, and against G. brevipalpis in Bugerere, Mengo continued to be highly successful. Consolidation operations against re-invasion of reclaimed country also made good progress in a number of areas. To the north-east of the Bunyoro reclamation area notable progress was made with the Kigumba Resettlement Scheme, mainly through the introduction on land-hungry Maragoli and Kitosh settlers from Kenya. In the Mitoma consolidation line of north Ankole a further big influx of settlers into the Bigyera Resettlement Area was another most welcome development. In Acholi the risks of re-invasion of the 1,800 sq. miles reclaimed area were still further reduced by bush-clearing of fly concentration sites in the Aswa drainage system north of the Gulu-Kitgum road.

Moroto River area: The principal tsetse control operations in 1957 involved a rapid initial survey of about 600 miles of water course, in February to March, and the spraying with one application of 6.2 per cent dieldrin on the river-bank vegetation along rather more than 300 miles of these water-courses in March to May. After completion of the initial spraying the area continued to be extensively patrolled, and supplementary spraying of all stretches of river still found to harbour the occasional tsetse was carried out. In the course of this follow-up work it was found necessary, in October 1957, to extend the treated area northwards to include the major Okee tributary. "Barrier spraying" of mile-long stretches of all the likely avenues of reinfestation around the periphery of the treated area was also undertaken at two-month intervals. Total expenditure of the 18.6 per cent dieldrin concentrate, "Dieldrex", was approximately 1,500 gallons. The overall result was that G. palpalis was successfully eradicated, at least temporarily from most of the sleeping sickness outbreak area; and no more than a very occasional fly could be found anywhere in the area by the end of 1957.

Extensive patrolling, and subsidiary spraying as necessary, continued throughout 1958. The total quantity of insecticide used was 393 gallons. This further spraying resulted, by August 1958, in a mean catch per mile of only 0.01 - representing only one fly per 100 miles of searching - and a subsequent still further reduction later in the year. With such very low levels of tsetse infestation prevailing throughout 1958 it is inconceivable that more than a few, if any, fresh infections of man by T. gambiense can have taken place.

Continued patrolling in the dry season of early 1959 revealed that some very slight re-infestation of the sprayed area was taking place. But this was mainly observed outside the central focal area - particularly in the relatively unimportant area east of the Aloi-Patonga road - and the resulting overall level of catch for the January to March quarter was still no higher than 0.14 per mile. It was thus strongly indicated that the level of catch in March 1959 was still a long way below the danger point for a resumption of transmission of the disease. Taking into account also the very relevant consideration of costs, and the further consideration that the re-invading tsetses from beyond the limits of the treated area would be unlikely to be infected with *T. gambiense*, it was concluded that continuation of regular patrolling and spraying at the 1958 level was unwarranted. During the last quarter of the report period the only further tsetse control action was therefore another "barrier spraying" in April. (It was also planned that this barrier spraying should be continued at three-month intervals until the dry season of late 1959, when a further overall resurvey of the fly position would be carried out.)

Kabiganda Valley, South Ankole: An isolated 17 sq. miles *G. morsitans* focus in the Kabiganda valley of southern Ankole was selected for a joint experiment with the Colonial Pesticides Research Unit in 1957. The object was to see if a residual insecticide, applied to the putative resting sites of *G. morsitans*, would eradicate the fly. After a period of preliminary sampling of fly densities, spraying with a 3 per cent dieldrin emulsion was started in October 1957, and continued until November 1958. The most promising spraying technique appeared to be a single application to the lower sides of the branches of the large trees - mainly *Acacia hebecladoides* - which occurred in the double-canopied concentration sites of the fly. The overall cost of this spraying was about Shs. 8 per acre.

The mean A.D.[*] for the valley before treatment was of the order of 33. After the treatment ended in November 1958 it was about 1 - indicating a reduction in fly density of the order of 98 per cent. Subsequently the mean A.D. figure remained around one for the rest of the report period. While complete eradication was not achieved the results of this experiment were most encouraging. It is felt that if such spraying were to be carried out on a practical, as opposed to the Kabiganda experimental scale, it should be quite feasible to make it fully effective. It appears probable, also, that practical spraying with large spraying gangs would cost considerably less than the above-quoted figure of Shs. 8 per acre.

Bugerere County: In August 1957 a small pilot scheme of insecticide spraying against *G. brevipalpis* was staged in *Bugerere* County. True *G. brevipalpis* habitat in this area is confined to the narrow strip of riverine forest which occurs in various places along the west bank of the Nile. The pilot scheme covered the northernmost stretch of infestation - the five to six mile strip of forest between Rwabiata and Kakoge. By the end of 1957 the indications were that this spraying had been entirely successful. By April 1958, by which time four more months of continued searching of the sprayed area with bait cattle had produced not a single capture of G. brevipalpis, this success had been confirmed.

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[*] A.D. = "Apparent Density".

On the basis of this successful pilot scheme and the evidence of further survey in early 1958 and the principal Bugerere focus of G. brevipalpis in the Busana-Nabuganyi region had by then become limited to an eight to nine mile stretch of riverine forest between Namutya in the north and Nakakandwa in the south, it was decided to attempt eradication of this main focus by similar means. The spraying of this stretch of forest, again using 6.2 per cent dieldrin, was carried out in September to November 1958; but unfortunately it did not reproduce the spectacular results achieved by the pilot scheme spraying of 1957. A big reduction in fly catch occurred, but occasional catches could still be made on the regular fly-routes throughout the period October 1958 to March 1959. This was most disappointing; and it was not until some time later that consultation with the Kenya Tsetse Control Authorities, who had been experiencing similar troubles in late 1958, revealed the probable cause. This was that some batches of the insecticide issued at that time had been made up with a new type of emulsifier, and the result of this in practice was a residue of large crystals of dieldrin on the sprayed vegetation which were relatively non-persistent.

In so far as the Bugerere operation was concerned the result of using this sub-standard insecticide was that, even though extensive subsidiary spraying was carried out in February 1959, the occasional fly could still be picked up in April and May. It consequently proved necessary to respray most of the focus with standard insecticide towards the end of May. (This insecticide had been kindly provided by the suppliers in replacement of the sub-standard material used in the initial spraying). No G. brevipalpis flies were subsequently seen anywhere in the treated area up to the end of the report period (and none has so far been captured to date.) It thus seems that the respraying in May 1959 was completely successful in eliminating the last remnants of this G. brevipalpis population.

Sukulu-Tororo Area: The virtually complete eradication of G. palpalis from a complex of about 100 miles of infested rivers in the Tororo-Sukulu region, by the use of insecticides, has been fully described in earlier annual reports. It need only be recorded here that, after six months of entirely nil catches throughout the treated area from May to October, 1957, the discovery of a small concentration of flies on the minor Turukuku River early in November necessitated the supplementary spraying of 3.5 miles of that river in that month; and that no more specimens of G. palpalis were captured anywhere in the treated area in December 1957.

The capture in early January 1958 of seven more flies, all of them on the Osia River within three miles downstream of its junction with the Turukuku, resulted in a further supplementary spraying of 8.5 miles of the Osia. From then onwards continued patrolling produced no more flies, either in the Turukuku-Osia area or anywhere else, up to the time the Tororo field station was closed down in March 1958 (and the specialist spraying staff and stores were transferred to north Lango). By that time there could be little doubt that complete reclamation of the Sukulu-Tororo area from tsetse had been successfully achieved. That this was so - and that no re-infestation of the treated area had occurred in the interim - appeared to be fully confirmed when not a single fly was seen during the course of an extensive resurvey of the area in May 1959.

(Annual Report of the Tsetse Control Department, January 1958 - June, 1959.)

WEST AFRICA

Trachyostus ghanaensis, Schedl: A great deal of time has been devoted to the "borer of wawa" with marked success. The borer is now established as a new species, Trachyostus ghanaensis, Schedl. It is host specific attacking only Triplochiton scleroxylon (Wawa), and is only able to live in growing trees. Economically this pest is of great importance to the quality of wawa lumber produced in Ghana and the Ivory Coast. The main factor downgrading wawa lumber is stain and this stain obtains entry to the heart of the growing tree along tunnels made by the borer. The possibilities of chemical control are very poor; silvicultural practices and the encouragement of the spread of predators and parasites of the borer offer the best hopes of control.

Protection of Floating Logs: Logs that are floated down rivers sustain a heavy attack by pinhole borers along the water-line. If remaining long enough in the water this attack will extend to cover the upper exposed surface of the log. Normal formulations of insecticide used on logs in the high forest are not suitable for floating logs. During this year a number of insecticide producing companies have prepared special formulations to meet this problem and one trial using these products has been possible in Ghana at Asamang on the River Offin. Results are tabulated below. Of the formulations used, the paint XY 59001 was most successful giving 96% protection over a 12 week period;

this contained gamma BHC at 0.75% concentration as the active ingredient. The greases tried, though easy to apply by brush, all usually came off in the water when the logs were floated.

The level of attack by pin-hole borers was disappointingly low and this may well have influenced the results. This trial does however show the possibilities of paint as a formulation. When the trial is repeated on a large scale in Nigeria aldrin formulated as paint will be included among the treatments to be tested.

THE PERCENTAGE PROTECTION GIVEN BY VARIOUS INSECTICIDAL TREATMENTS TO ATTACK BY AMBROSIA BEETLES ON FLOATING LOGS OF WAWA

Number	Treatments Name	Insecticide	Concentration of active ingredient	Types of Formulation	Number of holes /sq. ft.	% Protection of each Treatment over 12 week period
1	Control	Nil	-	-	3.65	-
2	Grease G	γ BHC	0.75%	Grease	1.22	67
3	Grease D	Dieldrin	0.75%	Grease	1.65	55
4	Grease A 75	Aldrin	0.75%	Grease	2.00	46
5	Grease A 15	Aldrin	1.5%	Grease	1.15	66
6	Grease M	Malathion	0.75%	Grease	2.65	28
7	Grease O	Nil	-	Grease	3.22	23
8	YF 5483	γ BHC	0.75%	Spray	0.98	73
9	YX 59001	γ BHC	0.75%	Paint	0.15	96
10	M 20	γ BHC	0.75%	Spray	0.41	89
11	EF 979	Dieldrin	0.5%	Spray	1.86	49
12	EF 890	Dieldrin	0.75%	Paint	1.16	68

Pests of seedlings: At nurseries in Kumasi seedlings of *Triplochiton scleroxylon* and *Terminalia ivorensis* (Emeri) were being destroyed by crickets which ate through the leading shoot. Treatment with a 1.0% "Gammaxene" emulsion proved effective. Reports have also been received of destruction of seedlings of the exotic *Gleditschia triacanthos* at Kpong in Ghana by Scolytids boring into the plants at the base of the leaf axil killing over 70%.

(Report of the West African Timber Borer Research Unit, 1958-59.)

NEWS ITEMS FROM OTHER PARTS OF THE WORLD

POLAND

Resistance to DDT of flies (Musca domestica L.) in Poland, 1953-1958: In 1952 numerous reports appeared on the ineffectiveness of DDT - spraying of walls in fly control, particularly in towns where DDT had been used on a large scale for the previous three years, as a result of the diminished susceptibility of house flies to DDT.

In 1953 field trials were initiated with a view to assessing the extent and the degree of resistance in house flies in different parts of the country. A test method was elaborated and an index for measuring the degree of DDT-resistance in various populations of flies was proposed. Samples of flies captured in buildings were exposed for 1 hour on DDT-impregnated papers and after 24 hours recovery period the numbers of surviving and killed flies were determined. The fraction - the number of survivors against the number of all flies tested - gives the value of resistance index.

The highest resistence level was noted in 1955; since 1957 some regression was observed, which probably was caused by the use of gamma-BHC in mixture with DDT in emulsions.

It is recommended to estimate the index of DDT resistance of flies when control actions on a large scale are planned. The authors assume that populations of flies having the index below 0.25 could be controlled with DDT; from the practical viewpoint at higher resistance levels the mixtures of DDT with gamma-BHC or other compounds (e.g. diazinon) should be used; when the index value exceeds 0.5 DDT should be entirely replaced by other insecticides.

(A. Bojanowska, Z. Wojciak. Przeglad Epidemiologiczny, 1960, 14, (1), 80-81.)

SUDAN

Tsetse control

The practise in the Jur Narrows is that of game shooting and eviction combined by insecticides on bait animals and hide screens, and followed by settlement. The fly is *Glossina morsitans*.

DDT dispersible powder (50 per cent) and "Gammexane, 520" dispersible powder, 50 per cent BHC (containing 6.5 per cent gamma isomer), are used on bait animals (cattle and sheep) and on hide (giraffe) screens.

"Gammexane" is used as a 0.5 per cent gamma BHC, and DDT as a 5 per cent suspension.

Bait animals are used to clear persistant pockets of fly in areas under control. They are driven in batches of not more than 20 héad into such pockets, the sheep, in view of their smaller size, being more capable of going into dense thickets.

Giraffe hides are hung along tracks, in and around suspected pockets and in areas where fly has been seen.

Effectiveness is adjudged by fly catches in the area, thus: there will be more males available than females in the beginning of operations (the area is undistributed) and that this apparent numerical difference gets smaller until the two sexes are nearly equal in number (the area is balanced) and towards the end of operations the percentage of females collected is found to be much higher than that of males (the area is under control).

(Ministry of Animal Resources, Annual Report of the Dept. of Animal Production 1st July, 1956 to 30th June, 1957.)

PROPRIETARY DATA

COPPER PEGLER & CO. LTD. Burgess Hill, Sussex.

A lightweight sprayer and "Flame-Thrower" lance are among new items of equipment contained in this firm's catalogue and price list for 1960.

The "Plafog" sprayer weighs only 2 lb., is 22" in length and holds ½ gallon of fluid. It works at high pressure (up to 200 lb. p.s.i.) and delivers a very fine penetrating mist spray. The brass pump has an all-metal piston (no cup leathers, etc.) and bronze ball valves, so that maintenance is negligible and very simple. The attractive container, of a special plastic, has been designed for ease of handling and to withstand rough treatment. It is easily filled, and the capacity of ½ gallon spray liquid enables spraying to be done quickly and without the delays of constant recharging which occur when a syringe is used.

Strongly recommended for spraying most bush and ground crops, for applying pig and other animal oils, for poultry house work, and many health purposes. Supplied complete with fine cone spray nozzle and angle bend.

The C.P. "Flame-Thrower" lance has been specially designed for the control, at comparatively long range, of various pests and weeds. Used with a "Leo" or "Favori" sprayer, or a power unit such as the "Hypermicrover", the lance projects a fierce flame, approx. 15 feet long. The flame is turned "on" or "off", at will, by means of an instantaneous trigger valve, and immediate combustion is ensured by the hooded pilot light. The lance weighs 4¾ lb. and is 5 ft. in length. Paraffin is the specified fuel.

MANUAL OF CROP PROTECTION IN COFFEE

Bayer, Leverkusen. pp.43, illus.

The object of this brochure is contained in the foreword: "to provide the coffee planter with essential information through the medium of illustrations and explanatory texts, which will give him valuable assistance in overcoming the difficulties confronting him in this very wide and versatile field of crop protection".

Accounts are given of some important diseases and pests occurring in coffee, and their control with Bayer crop protection products. Useful conversion tables of measures, weights and rates of application are also included.

MURPHY ADVISORY LEAFLET No. 9. issued April 1960.
Murphy Chemical Co. Ltd. Wheathampstead, Hertfordshire.

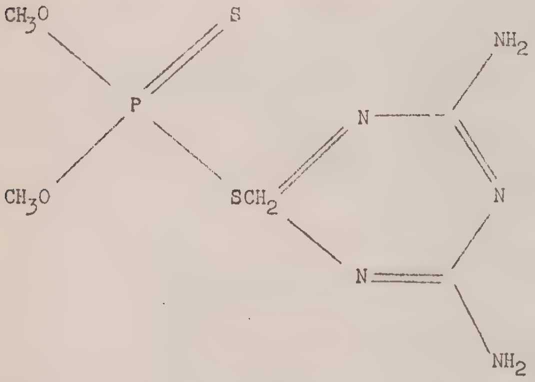
Contains particulars on the biology and control powdery mildew and red spider on apples and pears.

MURPHY ADVISORY LEAFLET No. 10. 12 pp. issued May 1960.
Murphy Chemical Co. Ltd., Wheathampstead, Hertfordshire.

This contains information on the life histories and control of codling moth and fruit tree tortrix moths, with particulars of Murphy pest control materials.

PP. 175

Plant Protection Ltd., Fernhurst, Nr. Haslemere, Surrey.



S-(4,6-diamino-1,3,5-triazin-2-yl) methyl 0,0-dimethyl phosphorothiolothionate.

Type: Persistent, systemic, OP compound of low mammalian toxicity. Highly selective though slow-acting against aphids, with relatively little activity against most other insect groups including beneficial species. Some injurous mite species are highly susceptible. Non-phytotoxic at normal dosage rates.

Properties: The pure material is off white, crystalline, with little or no odour, melting at 160-162°C (partial decomp.) Approximate solubilties at 20°C are; tetrahydofurfuryl alcohol, 15%; ethylene glycol, 10%; 2-ethoxyethanol (Cellosolve), 20%; 2-methoxyethanol (Methyl Cellosolve) 25%; Water, (0.1%). The solid, stable below 50°C, decomposes under strongly acid or alkaline conditions.

Formulation: PP. 175 is available as a dispersible powder containing not less than 70% a.i. Maximum suspension stability is achieved at pH 4. Stability range is pH 4-8. No suitable solvents have been found for miscible liquid formulation. Hydroxylic solvents tend to decompose the toxicant.

Toxicology: Acute oral, LD 50 rats (female) 900 mg/kg; rabbits 200-500 mg/kg. Intraperitoneal, single dose LD 50 rats (female) 280 mg/kg, rabbits 150-500 mg/kg.

Dermal application. A dose equivalent to 800 mg/kg applied on lint pads to the dehaired dorsal skin of rabbits for 24 hours produced no symptoms and cholinesterase activity was not reduced. A dose equivalent to 400 mg/kg as a 20% solution in polyethylene glycol, maintained in contact with dehaired dorsal skin of rabbits for 72 hours, reduced cholinesterase activity slightly.

Ocular instillation. One drop of a 20% solution in polyethylene glycol introduced in the rabbit conjunctival sac caused only temporary irritation and no other symptoms.

Chronic toxicity. Oral. In rats given daily doses of 100, 25 and 10 mg/kg over a period of 14 days only the highest dose produced toxic symptoms, but when tested at the end of the experiment there was some inhibition of plasma and erythrocyte cholinesterase from all dosages. Post mortem examination revealed no other abnormalities. Long term feeding tests are in progress.

Performance

Against Aphis fabae on broad beans one application at 6 oz. per acre eliminated a heavy population and gave complete control until the crop was picked 30 days later. Yield of green beans was increased from 50 lb. to 6,500 lb. per acre.

PP 175 has given good control at 3 oz. per acre of Myzus persicae on potatoes and sugar beet in the U.K.

A high volume spray (12 oz. a.i. per acre) reduced the percentage of Brussels sprouts infested with Brevicoryne brassicae, picked 6 weeks later, to 17% compared with 88% for the untreated controls.

A late spring application at 10 oz. a.i. per acre against Eriosoma lanigerum Housm (woolly aphid) on apples resulted in complete control. Satisfactory control is also reported for Typhlocyba quercus F (leaf hopper) and Smynthurus viridis Lubb (lucerne flea) and the mites Bryobia praetiosa Koch and Halotydeus destructor Tucker.

Recommendations

Foliage sprays should be tried against all aphids of economic importance especially where biological control is important in limiting populations. High volume sprays should be applied at concentrations of 100-300 p.p.m. Low volume sprays should apply 3-6 oz. per acre on field crops such as sugar beet and potatoes and 6-12 oz. per acre on fruit.

Seed treatments at dosage rates of 0.5-4.0% by weight on the seed. Suggested crops are sugar beet, cotton, alfalfa, and field beans.

Soil treatments at rates of 1-16 oz. per acre of active ingredient.

PP 175 is primarily an aphicide but tests on other pests including mites, leaf and frog hoppers and springtails are worthwhile.

Precautions

No special precautions are necessary when applying PP 175. It is, however, desirable to avoid exposure to the spray mist and to wash exposed parts of the body after spraying or accidental contamination with the material.

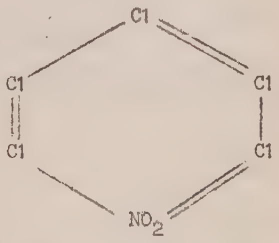
TERRACLOR

Olin Mathieson Chemical Corporation, Baltimore 3, Maryland.

'Terraclor' (pentachloronitrobenzene) is a soil fungicide highly effective for control of Rhizoctonia, Sclerotinia, Sclerotium, Plasmodiophora and Rosellinea. It appears to function as an antisporulant at relatively low concentrations, and possesses a useful residual activity.

Chemical and Physical Properties

The material is supplied as a light buff to white solid, melting at 142-5°C, with a musty odour. It is completely soluble in acetone, benzene, toluene, xylene, carbon tetrachloride, carbon disulfide and chloroform. Slightly soluble in methanol, ethanol and isopropanol. Soluble to about 2% in ethyl alcohol at 25°C. Insoluble in water. It is 98.5% pure, the impurity being pentachlorobenzene, with traces of hexachlorobenzene. It is stable when stored, is not subject to hydrolysis or oxidation at ordinary temperatures and is unaffected by sunlight. Generally speaking 'Terraclor' is compatible with all insecticides and fungicides with a pH of 7 or below which are similar in formulation.



Formulation

Dry formulations are free-flowing and have a fine particle size. At least 95% must pass through a 325 mesh standard screen by the dry brush method. Material is ground to a 5 micron specification. Dusts of 10, 20 and 40% strength are available, also 'Terraclor'/captan dusts of strength 10/10 and 20/10 per cent. Wettable powders include a 'Terraclor' 75% a 'Terraclor'-captan 25/25% and a 'Terraclor'-captan 50/25%. An emulsifiable concentrate contains 2 lb. PCNB per US gal. at 70°F.

Handling Precautions

When used under normal conditions, 'Terraclor' does not cause irritation. The inhalation of dusts and spray mists, however, should be avoided. This material may cause skin irritation and therefore hands and face should be washed thoroughly after using. It is advisable to wear gloves and a respirator when loading the duster or sprayer.

Toxicological Studies - Acute Oral

Rats. When pentachloronitrobenzene was administered to rats as an aqueous suspension of a wettable powder, the acute oral LD_{50} was greater than 12 g/kg. When technical material was administered as a 10% corn oil solution, the LD_{50} for male rats was 1.71 ± 0.20 and for females 1.65 ± 0.17 g/kg.

Rabbits. The corn oil solution administered to rabbits gave LD_{50} of approximately 0.8 g/kg.

Dogs. Technical grade material was administered as a 10% solution in corn oil in a dosage range between 3 and 25 ml/kg. No adverse symptoms were noted in the dogs studied.

Toxicological Studies - Chronic Toxicity

Rats were fed pentachloronitrobenzene at dietary levels between 0 and 2500 ppm for a period of 2 years. No adverse effect on mortality was apparent.

Phytotoxicity

There is no problem of phytotoxicity when 'Terraclor' is used according to recommended rates and methods of application. There is one possible exception to this and that is the application of 'Terraclor' to young lettuce plants. Depending upon environmental and climatic conditions at time of application, 'Terraclor' may cause slight marginal burning. However, this does not adversely affect the plants as they soon recover and outgrow this symptom.

Biological Effect

'Terraclor' has been found effective against the following pathogenic fungi:

- *Rhizoctonia* spp.
- *Sclerotinia* spp.
- *Sclerotium* spp.
- *Streptomyces* spp.
- *Plasmodiophora* spp.
- *Tilletia caries*
- *Botrytis* spp.

It is not effective against *Fusarium*, *Pythium*, *Verticillium*, *Phytophthora*, *Thielaviopsis* and *Aphanomyces*. 'Terraclor' also has been tried as a nematocide but without favourable results.

Typical Uses

Crop	Disease	Dosage (a.i.)	Application
Cotton	Damping-off	2-5 lb/acre	Dust or spray over seed and surrounding soil at planting.
Crucifers	Club root	20-40 lb/acre	Apply in 12-15" band before transplanting. Rototill to 4-6" depth. Use lower rates for lighter soils.
Peanut	Root rot	12-15 lb/acre	Surface band treatment
Wheat	Bunt, stinking smut	Apply 'Terraclor' 75% W/P at 1 oz. per bushel	

Other recommendations relate to its use on vegetable crops, potatoes, tomatoes, ornamentals and coffee (Rosellinea). It shows promise for use in the control of rice blast, Piricularia oryzae

Additional Literature Reference

Agricultural Chemicals, July 1957 issue.

SYSTICIDE

Pan Britannica Industries Ltd., Waltham Abbey, Essex.

Systemic insecticide recommended for aphis control on chrysanthemums and carnations.

COTTON: PEST, DISEASE AND WEED CONTROL

Well illustrated brochure (24 pp.) issued by Shell.

REGLONE

This is the registered trade mark for a safe potato haulm destroyer produced by Plant Protection Ltd. 'Reglone' contains diquat which is a quaternary ammonium compound.

AROCLOR RESINS

The use of these resins in insecticidal formulations for extending the active life of deposited insecticide is described in a chemical specialties data report issued by Monsanto (5 pp.).

LITERATURE NOTED

(A reprint is indicated by an asterisk)

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H. R. Moody. Agric.Chemic. 1960, 15, (4), 45-7.

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(based on a report by H. H. Shepard of the U.S.D.A. Commodity Stabilisation Service).
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INSECT PESTS ARE ALSO BIG BUSINESS: ABOUT £5 M. A YEAR SPENT ON FIGHTING THEM
L. J. Neethling. Econ.Opinion, 1959, 6, 13-16.

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ABSTRACTS

IMPERIAL COLLEGE, ANNUAL REPORT, APRIL 1960

Mode of Action of Insecticides

Using the radiotracer technique described in previous reports, comparative studies of oil uptake from residual deposits by a range of species are in progress. The principal purpose of this series of experiments is to assess the influence of size, structure and habit of insects on the rate of contamination by oil films.

The following results relate to insects exposed at 25°C to R.17 Shell oil deposits of 3 microlitres per sq.cm on filter paper.

Short Exposures

The initial rates of contamination varied between four species as follows:-

	Average Weight	Average Uptake for 20 minutes
Phormia terraenovae	60 mg	3×10^{-7}ml/minute
Dysdercus fasciatus	47 mg	$2. \times 10^{-7}$ ""
Tribolium castaneum	1.8 mg	2.3×10^{-8} ""
Carpophilus dimidiatus (Larvae)	1.8 mg	7.25×10^{-8} ""

Long Exposures

The near approach towards equilibrium between the oil films on insect and substrate is of interest in species such as *Tribolium* and *Carpophilus* which are commonly used in assays of long duration.

The soft-bodied, almost cruciform, larvae of *Carpophilus* rapidly acquire and retain a heavier external film than *Tribolium* adults of the same weight, although both species have the habit of almost continuous crawling in experimental conditions.

After about 5 hours, *Carpophilus* larvae have almost reached equilibrium with the deposit, having achieved an average external film of 6.5×10^{-6}ml oil and having absorbed 1.5×10^{-6}ml per insect. Additional oil is then picked up at a rate which exactly balances a very slow subsequent rate of absorption averaging 5×10^{-7}ml per day.

In contrast, *Tribolium* adults take about 24 hours to approach equilibrium, when the external film averages 3×10^{-6} ml and the absorbed quantity averages 6×10^{-6} ml per insect. Thus insects of the same weight but of different structure may differ widely in the rates at which they pick up and absorb oil.

Biochemical Studies

The work reported previously, namely, the effect of dieldrin on insect cholinesterases, has been continued on head extracts of both susceptible and dieldrin-resistant strains of the housefly, *Musca domestica*.

By the use of the specific inhibitor eserine sulphate it has been shown that in such extracts only the cholinesterases hydrolyse acetylcholine, and the effect of adding dieldrin at a final concentration of 1×10^{-3}M causes an inhibition in cholinesterase activity of 20-30% in both strains.

By the use of the specific inhibutors 1:5 - bis (4-trimethyl-ammonium-phenyl) pentane-3-one di-iodide for true acetylcholinesterase, and tetra-isopropyl pyrophosphoramide for pseudocholinesterase, it has been possible not only to confirm that adult housefly heads contain both these cholinesterases, but that true acetylcholinesterase is inhibited by dieldrin in vitro at final concentrations of 10^{-3}M, whereas under the same conditions pseudocholinesterase is activated. These experiments have been repeated many times to determine if there is a statistically significant difference in these effects between the two strains of houseflies. Except in one respect, which is being tested further, there appears to be no such difference between strains in the effect of dieldrin at concentrations in vitro of 10^{-3}M. Although this is a relatively high concentration of dieldrin, it should be pointed out that at present nothing is known of the actual concentrations achieved in vivo at the sites of action.

It is hoped to conclude this section of the work very shortly.

Acetylcholine is synthesised in insect heads from acetylcoenzyme A and choline chloride by choline acetylase. But the metabolic pathway of synthesis of acetylcoenzyme A in insects is not yet known. An attempt is being made to determine this and the effect of dieldrin on the synthesis of both choline acetylase and acetylcoenzyme A.

Olfactory Responses of *Stomoxys calcitrans*

The small choice chamber (see Pans (A), 1959, 5, 372) has been used to observe the responses of hungry flies exposed to the saturated vapours of certain ethyl and ammonium derivatives of straight chain fatty acids. Some results are given in the attached table. It will be seen that none of the esters were attractive and that the series showed a minimum effect on the flies and C_5 and C_6, after which repellency tended to increase with molecular weight. These results contrast with those given for normal fatty acids in the last report, the saturated vapours of acids being attractive over the range of C_{12} to C_{18}.

	Molecular weight	% time spent over stimulus	Frequency of stopping (Stops/sec x 10^{-3})	Length of pause (in sec)	Frequency of turning (turns/cm)
Ammonium butyrate	104	38	2.7	18	0.21
" valerate	118	47	2.5	21	0.15
" caproate	132	40	2.5	19	0.16
" caprylate	160	28	2.5	37	0.16
Ethyl butyrate	125	42	1.7	70	0.45
" caproate	152	50	1.4	36	0.17
" caprylate	180	38	1.5	16	0.19
" laurate	236	46	2.6	15	0.22
myristate	264	40	1.5	47	0.15
Sebum mixture	-	56	2.3	43	0.24

A mixture of fatty acids in the same proportions as they are found in human sebum (C12: 4 parts & C_{14} : 6 parts. C_{16} : 24 parts. C_{17} : 1 part. C_{18} : 8 parts - James and Wheatley 1956) has also been tested. The saturated vapour of the mixture was less attractive than palmitic acid, which is one of the more attractive members of the series and is also present in the greatest concentration in human sebum.

Preliminary work has been undertaken on formulations which reduce the evaporation rates of fatty acid constituents. To facilitate this work and allied experiments, a flame ionisation detector (McWilliam and Dewar, 1958) of high sensitivity has been constructed. It is being adapted for continuous or discontinuous sampling of experimental air-streams from olfactometers.

An electrophysiological technique is being developed to enable the electrical activity of sensory nerves in the antennae to be detected. Attention is at present concentrated upon the production of extremely fine electrode tips and their manipulation within the antenna. Tungsten electrodes are used and jigs to produce pairs of electrodes with tips of approximately 1 micron diameter and less than 5 micron apart have been devised.

The method of construction can be summarised as follows:- Two 46 S.W.G. tungsten wires which are held 2 mm apart are copper-plated, and then a copper lead is soldered to each wire. Approximately 2 cm in front of the attachment of the copper leads the tungsten wires are brought almost together by means of the two screws. The wires are then lacquered and allowed to dry. The tungsten wires are cut where they are close together and the tips sharpened evenly by electrolysis in potassium-nitrite solution. Two fine knife edges then move the tips together until they are the required distance apart. The tips of the electrodes are then insulated with a thin coating of lacquer.

COLONIAL PESTICIDES RESEARCH UNIT, PORTION. ANNUAL REPORT, 31st MARCH, 1960

Report No. 174.

The Toxicity of Candidate Insecticides to Mosquitoes and Houseflies.

The resistance of many insect vectors of disease to chlorinated hydrocarbon insecticides is a major problem in colonial public health programmes. There is a need for effective countermeasures, and a search has been made among other groups of compounds, notably the organo-phosphates, for materials toxic to normal and resistant strains of insects.

More than twenty compounds have been tested and evaluated, initially by topical application to determine intrinsic toxicity to mosquitoes and houseflies. The relative toxicity of any two compounds varied from one species to another. In general, the compounds tested were more toxic to Anopheles stephensi than to Aedes aegypti, but "Chlorthion" was exceptional in that it was more toxic to A. aegypti. Some of the compounds were not sufficiently toxic to warrant evaluation as residual contact insecticides. For instance, neither "Ruelene" nor "Dithion" were toxic to A. stephensi at a dosage of 0.11 μ g per mosquito, while the median lethal dose of "Delnav" was relatively high at 0.083 μ g per mosquito. "Trithion", with median lethal doses of 0.037 μ g for A. stephensi and 0.162 μ g for A. aegypti, killed only 13% of the former species in contact for 1 hour with wettable powder deposits at a dosage of 100 mg active ingredient per sq.ft on plywood panels. The most promising compounds, with median lethal doses of 0.01 μ g or less per female A. stephensi, were diazinon, malathion, "Chlorthion", "Resitox", "Gusathion", "Baytex" and "Sevin". These were evaluated for residual contact toxicity on a number of building materials.

Aqueous suspensions of wettable powder formulations were sprayed on to plywood panels at a dosage of 100 mg active ingredient per sq.ft ($1g/m^2$) and stored at 25°C. The residual contact toxicities of deposits to female A. stephensi are summarised as follows:-

Insecticide	Age of deposit	Mean percentage kill after contact of...........minutes					
		2	5	15	30	60	120
Baytex	1 week	100					
	7 weeks	90					
	17 weeks	39	98				
Malathion	1 week		36	100			
	7 weeks		5	80	100		
	20 weeks		0	15	85		
Chlorthion	1 week		5	60	90		
	7 weeks		5	49	76		
	20 weeks			5	48	85	
Diazinon	1 week	100					
	4 weeks			0	30	98	
	7 weeks				0	0	13
Resitox	< 1 day					0	0
Gusathion	< 1 day					0	0
Sevin	< 1 day					0	0

"Baytex" and malathion were the most effective insecticides and these should have a long residual action on plywood and similar relatively non-porous building materials at a dosage of 100 mg per sq.ft. Insufficient persistence was obtained at lower dosages.

Preliminary experiments indicated that deposits of "Baytex" and malathion wettable powders were as toxic to the BK dieldrin-resistant strain of A. gambiae as they were to A. stephensi. Unfortunately none of the compounds tested had a residual contact toxicity to mosquitoes on porous materials. No kills were obtained when female A. stephensi remained in contact for 2 hours with spray deposits from suspensions of wettable powders one day after their application to dried mud bricks made from a variety of soils with a range of sorptive properties.

Persistence of Insecticide Deposits

Evaporation and Decomposition of Insecticides

On non-porous surfaces the activity of deposits can be lost through evaporation or decomposition of the insecticide. The relative importance of these two processes has been determined with the compounds used in biological tests. Most of the compounds, including diazinon, "Trolene" (= Dow ET-57), malathion, "Baytex", "Resitox", "Gusathion" and "Sevin" gave no evidence of decomposition over a period of 8 weeks. "Chlorthion" and isochlorthion decomposed slightly over the same period. Any appreciable losses were, in fact, due to evaporation. The compounds tested could be arranged into three groups with regard to speed of evaporation. Diazinon and "Trolene" disappeared very rapidly indeed, only small residues being left after one week. An intermediate group consisting of "Chlorthion", isochlorthion, malathion and "Baytex" had a half-life of between 8 and 16 days. Very little of the remaining compounds, "Resitox", "Gusathion" and "Sevin" was lost in 8 weeks.

The substrate used in these experiments was filter paper from which evaporation could occur over the whole surface, and the insecticides used were pure materials applied as solutions. "Baytex", malathion and diazinon were also tested as residues from wettable powders on glass surfaces. The same order of evaporation rates was found, but the rate of evaporation of a given insecticide from glass was on an average about four times slower than that from filter paper.

Diazinon was used to investigate the influence of concentration of insecticide in a wettable powder on the evaporation rate. There was no effect over the range 20 to 40%.

On porous materials the main causes of loss of availability and persistence are sorption of the insecticide and subsequent decomposition. When aqueous suspensions of wettable powders were sprayed on to dried mud bricks made from a variety of soils sorption of all liquid materials (malathion, diazinon, "Chlorthion", "Baytex") was rapid and, as shown previously, resulted in a rapid reduction in the biological activity of the spray deposits. A proportion of the liquid insecticide usually separated from the inert carrier and formed an emulsion when the wettable powder was dispersed in water and this soaked into the porous substrate giving a much smaller surface deposit than did a dispersion of a solid insecticide which is filtered off at the surface. Measurements of the amounts of liquid insecticides left with the solid carrier of the wettable powder on a porous surface have now been shown that they can be less than 2% of the nominal dosage sprayed. This can be compared with the high recoveries of more than 90% obtained with solid insecticides on the same surface.

Organo-phosphorus insecticides which are solids at room temperature might be expected to behave in the same way as chlorinated hydrocarbon insecticides on surfaces made of soils with strong adsorptive properties. That is, the solid particles would disappear but the insecticide would subsequently be recoverable from the substrate. However, as it is known already that such soils are also good catalysts for the decomposition of organo-phosphorus compounds, this process might go on at the same time as or subsequent to sorption.

Experiments with dispersions of the pure solid insecticides in wetting agent solutions showed that there was considerable variation in the rate of sorption even on highly-active soils. Isochlorthion and "Trolene" deposits disappeared more rapidly than DDT and dieldrin but "Resitox" and "Gusathion" were much more persistent than the chlorinated hydrocarbons on a given soil. When the "Resitox" deposits did begin to disappear after several weeks the rate was greater at high than at low humidity, in contrast to the behaviour of DDT and dieldrin. This was shown to be due to concurrent decomposition of sorbed "Resitox" being greater at high humidity and this was accompanied by accelerated diffusion of the decomposition products deeper into the soil.

Once sorption has occurred the insecticide can decompose, and the stabilities of malathion, diazinon, isochlorthion, "Baytex", "Resitox" and "Sevin" on a variety of soil types have been compared. In general decomposition rates were greatest on the red lateritic earths previously found to be most active at sorbing chlorinated hydrocarbon insecticides but there were exceptions and the factors involved are probably complex ones. "Resitox" decomposed rapidly when sorbed on Uganda soil and had a half-life of a few days at 80% relative humidity. The rate of decomposition decreased as the relative humidity decreased. "Baytex" was much more resistant to decomposition on the same soil, and "Sevin" was stable. The products of decomposition of malathion and "Resitox" on the Uganda soil were found to be those expected from an acid-catalysed hydrolytic reaction, not an alkaline one.

Formulations

Work is in progress on formulations of liquid insecticides to increase dosages retained on the surface of porous materials and so increase their biological activity and persistence. Numerous malathion wettable powder formulations have been tested with little success. Sorption of the insecticide and diffusion into the substrate is rapid, even when a high proportion of the malathion is retained on the carrier in the suspension, or when the dosage of malathion remaining initially on the surface of dried mud is increased as a result of aggregation of carrier particles. Experiments with different types of inert carrier have also yielded negative results.

Observations on Some Solid Compounds

During the course of the previous investigations instances occurred of solid compounds (e.g. "Resitox", "Gusathion", "Sevin") with the following properties: low rates of evaporation, high retention as solid particles on the surface of porous materials, relatively high resistance to sorption on a variety of soils, stability, and high toxicity to mosquitoes when applied topically in solution. These should be satisfactory residual insecticides but unfortunately, spray deposits from suspensions of wettable powders and from suspensions of pure materials on a variety of surfaces exhibited low contact toxicity to *A. stephensi*.

One property these compounds have in common is very low solubility in paraffinic solvents, and work is in progress to correlate physical properties of solid compounds with their pick-up and penetration through insect cuticle. Measurements to date indicate that dosages of "Resitox" and "Sevin" picked-up from deposits by mosquitoes are significantly less than those of DDT under comparable conditions.

Histo-Chemical Investigations on Esterases in Mosquitoes

In view of the varying susceptibilities of different mosquito species to organo-phosphorus compounds it is intended to investigate the properties of the esterases in these insects and their response to poisoning by insecticides. A start has been made with work on the types and distribution of the enzymes in two species as shown by histochemical methods.

The central nervous systems of both *Aedes aegypti* and *Anopheles stephensi* possess strong acetylcholinesterase activity. This was demonstrated by substrate specificity and by selective inhibition. After poisoning by malathion, which is equitoxic to these two species by topical application, this enzyme activity in the nervous system was almost completely abolished.

Other esterases which hydrolyse aromatic esters but not acetylcholine occur in the gut of both insects although there are differences in distribution. These were not affected by eserine but were almost completely inhibited by organO-phosphorus compounds both in vivo and in vitro.

Bioassay of Lepidopterous Larvae

In a general study of the effect of insecticides on lepidopterous larvae, the change in weight with time of different instars of *Pieris brassicae* has been examined from egg to adult. Work on the response of larvae of different weights and instars to topical applications of endrin is in progress.

The toxicity of suitable solvents by topical application to *Pieris brassicae* larvae has been investigated and the following results obtained:

		Percentage mortality			
	larvae	After 24 hours		After 2 days	
		0.2 µl	1.0 µl	0.2 µl	1.0 µl
Di-isobutylketone	small	60	80	80	80
	large	0	100	80	-
Tri-n-butyl phosphate	small	100	100	80	80
	large	40	80	20	100
Ethyl laurate	small	20	100	60	-
	large	0	20	20	20
Tripropionin	small	0	0	0	0
	large	0	0	0	20
Butyl oleate	small	20	20	20	60
	large	0	0	0	0
Acetone	small	0	0	0	0
	large	0	0	0	0
Xylene	small	20	40	100	100
	large	0	40	20	20

Acetone is thus the least toxic, with triproprionin a suitable alternative. The high volatility of acetone should of course, be considered.

Other aspects of the testing of larvae have been examined. The repellency of a variety of materials when applied to the inside of a copper ring was studied. Naphthalene and p-chlor-o-cresol in vaseline were most effective and the following less so: naphthol, cresol, and terpineol, phenol, dimethyl-phthalate, dimethyl-toluamide, "Rutgers 612" (ethyl-hexane-diol), oils of lemon and eucalyptus.

The irritant effects on larvae of pyridine, and terpineol, allyl-isothiocyanate, naphthalene and p-chlor-o-cresol were also examined as of possible value in maintaining activity on an insecticidal deposit. Naphthalene and p-chlor-o-cresol were found to be promising irritants.

Attempts to attract larvae of Pieris brassicae and Busseola fusca towards plane-polarized white light were carried out. No conclusive differences to their known reaction to unpolarized light were found.

Pick-up of Insecticides

The amount of a dry-lipophobic dye, croceine scarlet, picked up by walking larvae of Busseola fusca, the African maize stalk-borer, has been determined. A dusting apparatus in the form of a settling tower has been constructed for obtaining deposits, and is in process of calibration and improvement.

Initial results indicate that for a "first-step" of 7 mm, when each appendage of a 3 cm., 280 mg VI instar caterpillar touches the deposit once, 0.013 mg of dye is picked up, or 0.005% of body weight. Pick-up is then exponential with distance up to a maximum, at about 100 cm., of 0.2-0.25 mg, or 0.01-0.09% of body weight. This is from a deposit of about 0.24 mg/sq.cm on No. 1 filter paper.

Maize Stalk Borer Control

Distribution of Spray on Maize

It has been shown that spraying the stems of young maize is important for field control of the maize stalk-borer, but that a deposit of insecticide in the central whorl has the most effect. The distribution of spray pattern on maize plants, 1 ft and 1½ ft high to the central whorl, was determined colorimetrically with croceine scarlet in water. From a height of 1 ft above the plants a flat spray 00 nozzle delivered about 27 gallons/acre over a swathe width of nearly 2 ft.

Details of the drop spectrum were recorded, 56% of drops being between 100-130 μ diameter, with a volume median diameter of 155 μ.

Between 7 and 33% by volume of the spray was retained on plants, depending on the height of plant and speed of travel over it.

Approximately 1-2% of the total spray retained on the plant remained on the stem, 4-10% in the whorl and 90% on the leaves. These proportions varied with the speed of travel and height of plant. Results are reported more fully in CPRU/Porton/Report No. 169 (PANS (A), 1960, 6, (1), 96-9).

Survey of the Use of Stalk Borer Control Methods

The results of a survey made in Kenya in 1957 have been analysed and given in a report "A survey of the use of maize stalk borer control methods in East Africa" circulated as CPRU/Porton/Report No. 163 (PANS (A), 1959, 5, (4), 524-5) and submitted for publication in the East African Agricultural Journal. It appears that among the more advanced farming community, up to 80% applied some form of insecticide treatment for the control of maize stalk borer. Of these the majority used hand application, but about 16% of those using insecticides applied them by tractor drawn sprayer. The methods of control were described, and a figure of 100 tons of dust and 500 gallons of emulsion was suggested as the amount of insecticide used for stalk borer control in Kenya in 1957.

Sampling of Field Infestations of Maize Stalk-Borer in Africa

The distribution of infested plants in a field in Western Tanganyika has been re-examined and a report issued on the statistical distribution found. It resembles a contagious, or compound distribution, in which the probability of occurrence of infested "hills" or plants is related to the probability of such plants being tall plants and found grouped on areas of old termite heaps.

The difficulty of selecting and deriving parameters for a sample of units of small numbers of "hills" or plants is discussed, and a sampling method based on the quantal criterion of attacked or not-attacked is given. The confidence limits, based on the binomial, for samples of different size have been plotted and a dot diagram of the infestation prepared. The economic value of confidence limits in terms of percentage infestation, and hence yield of grain, is derived from previous work.

Application of Pesticides from Aircraft

Investigation of the performance of the Dragonfly helicopter and S.A.6 boom and nozzle spray equipment in terms of dosage distribution, volume recovery, swathe width and underleaf cover for a droplet spectrum representative of that used in normal crop spraying is in progress. The object of the investigation is to determine how and under what conditions the performance of the helicopter as a spraying machine differs from that of a fixed wing aircraft.

Ground tests were made to relate pressure/throughput characteristics, and six of a scheduled programme of nine aerial trials with ground sampling layouts have been performed. These cover speeds ranging from 5 to 50 m.p.h. and operational heights of 10 to 30 feet. Results to date may be summarised as follows:

(a) The measured v.m.d. of the droplet spectrum ranged from 230 at 45 m.p.h. to 275 μ at 15 m.p.h. using Porton Flat spray nozzles, size '0' (jet area 0.0078 sq.cm), a sprayboom pressure of 130 p.s.i. and water as the spray medium. Reduction in sprayboom pressure to 100 p.s.i. at 10 m.p.h. increased the v.m.d. to 390μ.

(b) Ground recoveries averaged 65% and the volume of drift sampled 180 yards downwind of the aircraft track did not exceed 1% of the emission under any combination of spraying conditions.

(c) Uniformity of the main area of deposit depended upon several factors, notably positioning of the nozzles on the sprayboom, operating speed and height, and prevailing wind. The tendency towards peaking of the deposit density distribution under the aircraft track at the lower height/speed combinations (less than 20 ft/15 m.p.h.) due to intense impaction produced by the fast moving air of the rotor downwash has not been entirely eliminated but can be restricted to a 3-4 fold overdose at the centre of an effective swathe width of 10 yards. A rather more even density distribution is achieved in general at a height of 30 ft, but then the effect of the rotor downwash is dissipated to a considerable extent. Effective swathe width varied between 7½ and 20 yards, the criterion being 0.25 lb of active ingredient per acre sprayed in a 2½% solution.

(d) At speeds of less than about 15 m.p.h. and height of 20 ft or less, the nature of the stains sampled on collectors in the vicinity of the aircraft track showed clearly the effect the rotor downwash has on the form of the deposit. Many thread-like stains running in one or more directions indicated the considerable horizontal velocity component of the drops just above ground level.

(e) The effect of the intensely disturbed air was demonstrated on a number of occasions by violent fluttering of unpinned corners of sampling envelopes, and also on one occasion by several glass sampling plates being lifted and flung off the flat pieces of card on which they were placed. The feature of enhanced "underleaf cover" is visualised as being due to the high degree of flutter readily induced in many types of foliage with consequent exposure of both surfaces of leaves to spray impaction. This question of "underleaf cover" is to be investigated in more detail with more appropriate sampling techniques in a continuation programme.

(f) It is of interest to note that with the helicopter at speeds of 40 m.p.h. and over and a sprayboom pressure of 130 p.s.i., the v.m.d., the dosage distribution, swathe width and percentage ground recovery showed marked similarity to the corresponding parameters previously recorded with similar boom and nozzle equipment on the Auster J.5.G. aircraft flown at 70 m.p.h. and with a spray boom pressure of 55 p.s.i.

Wind Tunnel Studies

Use has been made of the one foot square section wind tunnel to obtain further data regarding the deposition of small diameter droplets on obstacles and collecting surfaces. With the present design of the entry section the tunnel can be run at speeds of up to 10 m.p.h., and a uniform mass flux of fairly homogeneously sized drops derived from a spinning top generator can be achieved at the working section.

An initial series of measurements has been made to determine the sampling efficiency of a set of small diameter cylinders, 0.15 to 1.0 in., with a droplet cloud of v.m.d. 30 microns at wind speeds of 2 to 5 m.p.h. Correlation with published theoretical data for monodisperse droplet systems is being examined.

Some further work has been carried out in an endeavour to relate the performance of test sampling surfaces such as absorbent paper, plain glass and magnesium oxide plates in both laboratory and field conditions, without so far revealing entirely consistent behaviour.

Fluorescent Tracers

There is a need for the development of an adequate technique for the bulk estimation of very small volumes of liquid, such as the sample of a spray obtained on the slides of a cascade impactor (10^{-4} c.c. or less) or the amount of spray deposited on locusts and other insects. Such small quantities are found to be just outside the limit of accurate quantitative measurement by the most sensitive colorimetric techniques.

First indications suggest that fluorescent tracers can be found with adequate sensitivity providing that they are also light stable. A twin-beam null-point fluorimeter of the Dowdall and Stretch pattern with modified power circuit has been constructed, and comparative measurements of the sensitivity of possible tracers for field and laboratory use have commenced.

COLONIAL PESTICIDES RESEARCH UNIT, ARUSHA, TANGANYIKA
ANNUAL REPORT 1959-1960

INSECTICIDES

Tsetse

Field Experiment, Chungai

In 1958 the Northern block at Chungai was unsuccessfully treated with a coarse aerosol of γ BHC. From July 1959, to March 1960, the same area was treated again, with the following modifications in technique; 2½% dieldrin was used instead of 5% γ BHC, swathe width was reduced from 70 to 55 yards, volume dosage increased from .08 to .125 gal/acre per application and eight applications made instead of seven. The insecticide was prepared by diluting with power kerosene at 20% w/v solution of dieldrin in a special high aromatic solvent supplied by the Shell Company of East Africa Ltd.

The block is the northern part of a 25 square-mile piece of thornbush and thicket which was divided into two by a mile-wide clearing in 1957. It is about 11 square miles in area and containing abundant G.morsitans and some G.pallidipes. Vegetation in the clearing is regenerating strongly. The south block is the control area for G.morsitans but there is none for G.pallidipes. The first three applications were made by flying over a single marker which moved along the southern (clearing) edge of the block, emitting on the northward run only. For the last five applications, another marker moved along the northern edge of the block and the aircraft ran over each marker alternately, emitting on both runs. Tracking was remarkably accurate, and by spraying in both directions dead flying time was cut by 45% and more ground could be covered before meteorological conditions deteriorated.

The result of this experiment was very satisfactory despite a number of setbacks. Catches of G.morsitans were at a very low level from the sixth application onwards, but G.pallidipes appeared relatively more frequently if we allow for its initial lower numbers. It is unlikely that further economies can be made by such things as increase in swathe width, simple reduction in volume dosage etc. It was noticeable that after spraying, catches did not fall at once but only over a period of two or three days. This suggests that many insects were receiving a barely lethal dose. As discussed later (laboratory work) the dieldrin experiment had the advantage over the γ BHC not only of a narrower swathe but that a lethal dose was carried in a smaller drop which should penetrate vegetation better. The number of lethal drops was of the same order. Economies could be made with a more lethal insecticide of comparable price which could be used in less concentrated form, or which would be held in a still smaller drop with improved penetration. Of more effect would be a disseminating mechanism which produced fewer drops of 50 μ and upwards. In this way the same number of useful-sized drops could be produced from less liquid, reducing the volume of insecticide solution which has to be bought, transported and disseminated and thereby reducing the cost of these processess. A full account of this experiment will be prepared when sufficient post-treatment catches are available for its proper assessment (C.P.R. Miscellaneous Report No. 263).

Field Experiment, Kabiganda Valley, Uganda

The spraying of this area was completed in November, 1958, Searches on flygrounds were continued until August, 1959. A very great reduction in the tsetse populations of the valley was achieved, but small numbers still remained. It was thought possible that the few remaining flies in the area were being brought in by the buffalo which frequently came over the hills from neighbouring valleys and hence that insecticidal applications of this sort if carried out over a wide enough area might eradicate a tsetse population.

Topical Applications of Insecticides

A Kerr type microburette (Kerr 1954, Bull.ent.Res., 45, p.323) has been used to apply small drops of insecticide solutions to the scuta of G.morsitans and G.swynnertoni. Dosages (micrograms per fly) recorded at different intervals are tabulated below: (lighting kerosene was used as the solvent.)

G.morsitans		DDT	BHC	Dieldrin
L.D.50	male	.015	.0031	.00078
	female	.027	.0036	.00090
L.D.95	male	0.12	.0090	.0044
	female	0.18	.0097	.0055
G.swynnertoni				
L.D.50	male		.0026	.0045
L.D.95	male		.0045	.0098

From the calculated figures listed in the following table it is apparent that only with dieldrin or gamma BHC can a lethal dose be contained in a drop of suitable size to penetrate vegetation.

Insecticide	95% lethal drop (for G.morsitans males)		
	diameter	loss by evaporation %	diameter when produced
DDT	105	50	130
	80	75	130
BHC	80	50	100
	80	75	125
BHC gamma	44	75	70
Dieldrin	35	87.5	70

Mosquitoes

Taveta-Pare Malaria Scheme

This scheme has now been brought to a close, the last spray cycle having been completed in April 1959, and a report on the scheme written by the Director of the E.A. Institute of Malaria & Vector-Borne Diseases (published by the East Africa High Commission, 1960.) (see this issue page 363).

The average monthly spray catches for February and March 1960, i.e. from fourteen months after the last cycle of residual spraying, were 1.3 and 9.1 A.gambiae for treated houses and 2.5 and 23.6 for untreated houses, for the whole area. These figures show a great increase compared with densities of 0.1 and 0.7 a year ago. Densities of A.funestus group remained very low. The average catches from untreated huts suggest that A.gambiae in Taveta forest has already exceeded pre-spraying densities. Box shelter catches of gambiae in the forest, and the funestus group at Mata, are also considerably greater than a year ago.

Experimental Huts, Magugu

The huts treated with BHC/Cereclor at 0.5 grams per square metre two years ago (April 1958) are still giving 100% kill of A.gambiae in bioassays with 3 hour exposures on the mud walls and 8 hour exposures on the grass roofs. It is proposed that the kill of naturally entering A.gambiae in those huts shall be determined during the present mosquito season.

Twelve experimental huts at Magugu have been reroofed and relined with absorptive or non-absorptive mud, or plywood, in preparation for studying the performances of two new insecticides - Baytex and malathion, as part of the insecticide testing programme of World Health Organization. The experimental huts have been modified to increase the number of gambiae entering them. The eaves are now nearer the ground and two Africans, instead of one, sleep in each hut. An average of 26 gambiae per hut were collected by morning catches in March. Panels of non-sorptive and sorptive mud from Magugu have been prepared in an Uniport "Altent" at the Arusha laboratory for preliminary bio-assay of the insecticides.

Hut Experiments, Muheza

Four new experimental houses have been built. They are each eight feet square with a wall 5'6" high with provision for a window trap to be placed on each wall. Between the top of the wall and the roof there is a double wall plate which provides an eave gap exactly six inches wide around the whole of the house. The houses are constructed of materials used by the local inhabitants in that area (mud brick plastered with mud, and a makuti roof). Families consisting of parents and children are being encouraged to live in the houses to serve as bait for the mosquitoes.

The main purpose of these investigations is to develop an experimental house into which there is a maximum entry of mosquitoes and in which the number of mosquitoes collected in the window trap will be a known proportion of the total population entering the house. The first step of the investigation, which is now in progress, is to determine whether or not there is an optimum side for the window trap. On completion of this step the investigation will be extended to determine the optimum eave opening which will result in the maximum number of mosquitoes in the window trap. At a later stage, trials on eave louvres and positioning of the window trap with respect to height above ground level will be carried out.

Laboratory Experiments

The median lethal concentrations of various strains of Anopheles gambiae have been compared with respect to DDT, gamma BHC and dieldrin. A colony of A.gambiae successfully established at the Unit several years ago has been maintained as a colony at the East African Institute of Malaria and Vector Borne Diseases with the female gambiae obtaining their blood meal from human volunteers; at Arusha it has been found possible to use rabbits as the source of the blood meal.

Both the adults and the larvae are reared at 26°C. At this temperature the length of life from egg to pupa is approximately nine days with a larval mortality of 5.0%. The pupal mortality is 1.5% and the average daily adult mortality at 26°C is 1.5% for the females and 1.8% for the males. Peak fertilization (80%, as determined by examination of the spermatheca) is reached in seven days and from 55-75% of the female mosquitoes from the age of three days feed on rabbit. The average daily egg production for a cage of 400 males and 400 females is 6,000 eggs, with a total daily colony production of about 100,000 eggs. The wing length of the females is 3.23 ± 0.12 mm.

During the course of investigation on the colony several rearing temperatures were tried (20, 23, 26 and 29°C) and it was obvious from the results that 26°C was the optimum. A comprehensive report on the colony with information on the breeding technique and the effect of these different temperatures is now being written.

The treatment of A. aegypti with dieldrin in the attempt to produce a dieldrin-resistant strain has now been carried out to the tenth generation with no change in the MIC except that which appeared temporarily in the second generation.

Pseudotheraptus on Coconuts

There is little evidence from Tanga to indicate that insecticidal control of this pest has had any appreciable effect on coconut yield. The results do, however, suggest that an appreciable increase in yield, and one likely to be maintained, will be obtained by clean cultivation of the ground beneath the palms instead of the present system of allowing the growth of grass, weeds and bushes to go almost unchecked.

At Zanzibar work has continued on the maintenance of a laboratory colony of Pseudotheraptus wayi. Investigations are in progress to determine the amount of damage by Pseudotheraptus necessary to cause shedding of vidaka and the period during which vidaka are susceptible to this damage. Considerable attention has been devoted to the study of an hymenopterous egg parasite, which has not yet been identified.

Cotton Pest Control

Two experiments were carried out against pests of cotton grown at C.P.R.U. In the first DDT at 1 lb per acre per application was shown to be more effective than "Sevin" at 1 lb per acre/application. "Rogor" and "Metasystox" were tested in the field against red spider and both gave extremely good control at the same dosage rate, (approximately $\frac{1}{8}$ pound/acre/application).

Persistence of Parathion on Coffee Leaves

It was found that the rate of loss of deposit from the surface of the leaves could be represented by a regression equation of the form:

$$\log_{10}(x + 1) = a - b \log_{10}(t + 1)$$

where x = parathion residue in mg per square metre of leaf surface,

t = time in hours after spraying,

a = initial deposit of parathion,

and b = regression coefficient.

Biting Fly Research, Uganda

Field Work

In September field operations were transferred to a site in the Koja Peninsula, 70 miles by road, east of Entebbe.

The experimental area comprises two malukas (districts), Mutuba II, (area 17 square miles) and Sabaddu (area 17 square miles) in the Gombolola Sabaddu, Kyagwe County. Mutuba II includes the whole of the Koja Peninsula which extends for 9½ miles in a south-westerly direction from the north shore of Lake Victoria. It was considered that Mutuba II would be an ideal area for control experiments as the lake precluded immigration of flies, except on one side; Sabaddu was to be used as a "control".

A survey showed that there were about 60 cattle kraals in the peninsula, containing 2 to 40 head of cattle per kraal and a total of 1,048 head of cattle. Fly rounds on two herds in each maluka were started at the end of December, two fly boys being allocated to each maluka. Catching is carried out on each herd three days a week, the two herds in each maluka being visited on alternate days. Detailed records of the Stomoxys species and sexes have been maintained.

A planned control experiment against the fly using chlordane in an emulsion spray was disrupted by adverse weather conditions.

Laboratory Work

A series of insecticides has been accumulated including all the main chlorinated hydrocarbons and about ½ dozen organo-phosphorus chemicals, and a start has been made on determining their L.D.50's against Stomoxys. The chlorinated hydrocarbons have been purified by re-crystallisation and the pure active ingredients of the O.P. compounds have been received from the manufacturers. As the L.D.50's are to be determined by using the "Agla" syringe, it is not possible to use formulated compounds.

The insecticide was applied to the mesothorax of female Stomoxys (males were found to be more susceptible than females), by means of the "Agla" syringe, modified by the incorporation of a nylon toothed wheel, operating on a sprung plunger. (Modifications designed and produced by Mr. T. R. Jones, Kawanda Research Station, Department of Agriculture.) In all applications the dose applied was administered in 0.00013 ml. of the solvent, and the dose varied by using different concentrations. Mortality readings were taken 24 hours after treatment. The L.D.50 for DDT and BHC was found to be 0.0156 microgrammes, and 0.00127 microgrammes of the para-para and gamma isomer respectively.

Further work with the other insecticides ceased due to dying off of the laboratory colony for reasons so far unknown. Steps have been taken to re-build the colony, and new cages constructed, accompanied by an even further strict check on the subordinate staff in charge of the insectary.

FUNGICIDES

Copper on Coffee Leaves

The frequent applications of copper oxychloride wettable powder to coffee trees at Lyamungu have continued. The leaf retention has risen from 32 to 75% and the incidence of Hemileia has not exceeded 1%. A preliminary attempt has been made to determine the effect of spray deposits on the actual copper content of the leaves as distinct from the deposit on the leaves. Results are given below:

		Days after spraying					
	Before spray	0	14	31	45	56	70
Surface deposit copper mgm/m^2	Nil	105	75	56	57	52	41
Copper content p.p.m./dried leaf	10		26	34	30	34	30

West African Fungicides Research Unit

Further improvements have been made in a laboratory technique for assessing the effectiveness of fungicides against black pod (Phytophthora palmivora) of cacao. None of the fungicides tested, with the exception of a cuprous oxide formulation, proved significantly better than Bordeaux mixture. A chemical technique is being further developed for the estimation of residues on the pods. Good correlation of laboratory results has been obtained in a field trial at Owena.

HERBICIDES

Trials with hormone weed killers for the control of the woody species Lippia javanica, Aspilia sp. and Solanum incanum have been started. An investigation is proceeding on the control of Cyperus spp. Results are reported of trials for the control of other herbaceous weeds including Oxalis spp., Trichodesma zeylanicum and the effect of dalapon on grassland weeds. Other investigations are concerned with weed control in coffee, beans, maize and pyrethrum. The growth of several water weeds was suppressed for three months using aminotriazole at 20 lb/acre.

MOLLUSCICIDES

An application of the new Bayer molluscicide on the Mwea-Tebere irrigation scheme resulted in a high mortality of snails for a period of three months at an estimated dosage of 0.75 p.p.m. for 8 hours. Fish were killed throughout the area at concentrations as low as 0.25 p.p.m.

PERSISTENCE OF ALDRIN IN SOIL

Aldrin in the form of a diluted emulsion concentrate is sprayed on to the soil during the planting of sugar cane to control the red cane beetle (Cochliotis melolonthoides). Soil surface temperatures can exceed 50°C and it was thought that there might be considerable loss of aldrin from the soil during the period between spraying and the final covering of the insecticide. It was found, however, that there was no significant loss of aldrin during a period of three hours, when sprayed on to the soil at a rate of approximately 1 lb/acre, with an average soil surface temperature of 48°C. Neither was there any significant loss of aldrin during a seven hour period when applied at 1.5 lb/acre with an average soil surface temperature of 50°C for the first two hours and a subsequent average temperature of 30°C. The insecticide is usually covered with soil within 2 hours of being applied and consequently any loss of aldrin from the soil due to volatilisation at high soil temperatures is negligible.

MISCELLANEOUS

Assessment of Methods of Application

Work in this section is largely on methods of application and of the correlation between physical and biological results. Assessment procedures are described.

Equipment

The report also refers to the construction of a molluscicide dispenser and a motor driven wall sprayer; to drop spectra from rotary brushes fitted to a D.H. Beaver aircraft and to rotary atomisers fitted to an Auster.

For accounts of other topics, viz. drift of toxic chemicals, drop spectra from rotary brushes fitted to D.H. Beaver aircraft, pick-up of the insecticides by settled locusts, and rotary atomisers fitted to an Auster aircraft, see PANS (A), 1960, 6, (1), 76-77.

THE DISTRIBUTION AND SAMPLING OF MAIZE PLANTS INFESTED WITH THE STALK BORER, BUSSEOLA FUSCA, FULLER IN TANGANYIKA.

P. T. Walker. Colonial Pesticides Research Unit, Porton.
Report No. 173. March 1960.

In this paper the author examines the statistical implications of sampling and distribution with particular reference to stalk borer infestation.

A reliable sampling technique is prerequisite in the assessment of large scale control operations and for pest surveys as a basis for control and yield forecasting.

The incidence of stalk borer attack is estimated conveniently by counting damaged plants or "hills", (discrete groups of plants sown together). The time at which counting is made is important, as is also the skill to recognise distinctive marks of damage at various stages.

With reference to measurements taken in an experimental field plot the author shows that distribution of infested hills is not random. It is thought likely that the moths are attracted to tall plants, there almost certainly being a positive correlation between attack and height.

The various types of distribution (attractional, migratorial, contagious and frequency), and random selection, are examined at some length.

PARE-TAVETA MALARIA SCHEME

Report on the Pare-Taveta Malaria Scheme 1954-1959.

A report on this scheme extending over a period of five years has been published by the East African Institute of Malaria and Vector-Borne Disease in conjunction with the Colonial Pesticides Research Unit.

Its object has been to assess the relative importance of malaria to other endemic diseases under the high transmission rates found in E. Africa.

The report is presented in eight sections with four appendices. Section I and II respectively outline aims of the scheme and present a background of the Country and its people. Section III is on residual spraying. Details of the spraying routines are reproduced below.

Investigations on the susceptibility (and resistance) by mosquitoes and other insects to insecticides are described in Section IV. Resistance of A. gambiae to dieldrin was at first suspected but later work, supported by the failure to find any evidence for the existence of a resistant gene in the area, evinced no change had occurred. Over the same period, the naturally resistant Culex fatigans became more resistant to dieldrin, and Anopheles funestus disappeared. Bed bugs seemed highly resistant after 18 months, and the common flea was shown to possess a natural resistance after about 30 months. Section V describes at length the assessment of change in Anopheles. The estimated effect from the age structure of the gambiae population was that the daily mortality of gambiae was increased by about 10% to 21-25%, theoretically inadequate for the interruption of transmission. Alternatives of food and shelter are assigned as probable reasons for the surviving gambiae population.

Section VI "The Reduction of Malaria in Man" records that overall differences in the response to residual spraying, in terms of a reduction of parasitaemia, were less than might have been expected. The effect was greater in areas where man predominated as host. In Section VII, "The Assessment of the Effects of Malaria Control upon the Health of the Community", the outstanding change recorded has been the general rise in haemoglobin values.

Section VIII, "Appraisal of the Results", briefly reviews the operation. Among the points made are:

1. transmission had been lowered to a level at which malaria must have become a disease of insignificance in the areas concerned.

2. a tentative conclusion that the survival of A. gambiae population was due to its catholicity of habit, both in feeding on man or other mammals and in resting within or outside the house.

Detail of spraying routines (Appendix II)

1. Clothing. This consisted of a polyvinyl chloride cap with a neck flap that came down to meet the overalls, and a perspex visor some 7 inches long, completely shielding the face. Dust respirators, used at first, were later abandoned. Cotton drill overalls that extended to the wrists and ankles. Medium weight rubber gloves (post-mortem gloves) which were protected in the later stages by cotton gloves worn over the rubber, were worn by the spraymen, but, because of wear, pumpmen wore plastic gauntlets. Gumboots; it was considered that a rubber and canvas sports boot would have been more suitable, and several sprayers were permitted to use these in the later stages. The teams were instructed to wear as little as possible under the overalls.

Instructions were given that the overalls should be buttoned at the wrist and up to the neck. Washing of all clothing was carried out daily (whenever possible), with soap and water under supervision, this being done before the evening meal. As gloves had to be washed from time to time during the day, dusting powder was carried in order to facilitate their putting on again. In the last round, overalls were also washed once a week in petrol.

2. Protection against Dieldrin Poisoning. Apart from the first line of protection given above, sprayers were instructed not to spray above their heads, and the pumpman to keep out of the room in which spraying was actually taking place. Measurement and mixing of insecticide were carried out in the open, the operator standing upwind of the containers. Insecticide was weighed out into haversacks, that were lined, by long-handled dippers, and removed from the haversacks by tin dippers. The insecticide was placed at the bottom of the bucket, and stirred with a stick (often the lance) as water was added. Attention was given to the stacking of insecticides away from the personnel, and to the regular cleansing of the trucks used for transport.

Apart from an occasional drink, food was not usually eaten during the day's work; but operators were instructed always to wash their hands before doing so, and their hands were scrubbed at the end of the day, after weighing-in the balance of insecticide left over, and refilling haversacks. It proved difficult to keep spraying clothing separated from bedding.

3. The Spray Mixture was prepared as indicated above. It consisted of $3\frac{1}{2}$ ounces of 50 per cent water dispersible powder to the gallon on the first cycle, changing to $1\frac{3}{4}$ ounces in subsequent cycles. The accuracy of the mixture was ensured by the measured tin containers for the powder, and by buckets, calibrated by brass markers, into which the water was measured. The amount of mixture actually used was checked by:

(a) The amount used daily in relation to the number of houses treated.

(b) The actual daily measurement with a ruler of a proportion of the houses (not less than 7 per cent) against the amount of mixture used in that house.

4. Organisation. In the absence of adequate maps of the area, the necessary preliminary was to locate all houses, and plot their position on sketch maps. This was not done for individual houses, but they were shown as blocks, with the total of houses in each block added. Gaps in these maps were found, especially during the first round, and more than one revision had to be made.

A general spraying plan was prepared at the beginning of each cycle; with the help of the maps, the work two or three days ahead was decided, and chiefs notified; and the actual daily tasks for each team fixed the night before.

It was found that one supervisor, who ever he was, could not fully supervise more than four or five spraying teams, and even this is difficult if houses are very scattered. Each driver-supervisor thus had direct charge of four teams, and the Field Officer exercised over-all supervision, especially with regard to the checks of dosage; he also had to find time to go ahead and warn headmen or chiefs.

The spraymen were required to enter a record of each house sprayed, in a notebook, and daily summaries were prepared from these, together with vehicle mileages, and other materials used.

5. House Sizes. As already indicated, not all houses were measured, but typical weekly averages varied from 880 to 1,300 sq. ft. The range of house size was very considerable, from fishermen's temporary houses, which were not many, of about 400-450 sq ft, to those of the more affluent in the large villages, varying between 3,000 and 4,000 sq ft of wall surface, of which there were again few. The typical houses lay between these sizes, and the average house was between 1,000 and 1,500 sq ft.

RELATIONSHIP BETWEEN PHYSICAL AND BIOLOGICAL ASSESSMENTS OF THE PERFORMANCE OF A SPRAYING MACHINE AGAINST COFFEE LEAF MINER, LEUCOPTERA MEYRICKI.

D. YEO, K. S. McKINLAY, C. E. McKONE. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 254.

The object of this investigation has been "to determine to what extent a physical assessment of the performance of a machine and a laboratory assay with the chosen insecticide could be used to predict the degree of control likely to be obtained in the field".

The authors adopted the method of correlating the mean deposit as estimated by the physical assessment, against the dosage mortality curve obtained in laboratory bio-assay, to give probable field mortality.

Prediction was shown to be in reasonably close agreement with results obtained in the field. The main discrepancy was between the physical assessment showing no significant difference between total leaf deposits at any height, and the kill of leaf miner which was significantly less at the two foot level. It was thought to be because a dipping technique, which would not discriminate between upper and lower leaf surfaces, had been used in the bio-assay.

The bio-assay, field trial and physical assessment procedures are described. The machine was an Autoblast air-assisted hydraulic sprayer. Field application was with a spray containing parathion on a block of multiple stem coffee. Biological records were restricted to the estimation of larval mortality within the leaf. The physical assessment was made three weeks later using water stained with Croceine scarlet dye.

TESTS WITH MALATHION WETTABLE POWDERS

Colonial Pesticides Research Unit, Porton. Report No. 172.

This report relates to tests carried out during the period May 1959 and March 1960, with various malathion wettable powders, the object being to select a suitable material for use in overseas field trials.

The persistence of spray deposits (100 mg/sq.ft) obtained from these formulations has been assessed on plywood panels, glass plates, and porous dried mud bricks prepared from various sorptive African soils. Test insect was Anopheles stephensi (♀).

Two formulations provided by Ratsouris Ltd. and Cyanamid respectively, exhibited prolonged biological activity on plywood (at least 20 weeks) but loss of activity on the sorptive surfaces was rapid (within 3 days).

NEWS ITEMS - GENERAL

CARCINOGENIC RISKS IN FOOD ADDITIVES AND PESTICIDES

The Food Standards Committee and the Advisory Committee on Poisonous Substances Used in Agriculture and Food Storage have both encountered problems in assessing the possible carcinogenic hazards from substances used as food additives or pesticides on growing and stored crops.

The Committee on Medical and Nutritional Aspects of Food Policy therefore invited a number of persons with special knowledge of the subject to meet under the chairmanship of Professor Sir Charles Dodds, M.V.O., F.R.S., D.Sc., M.D., F.R.C.P., F.R.I.C., to report to it on the principles that should govern "the assessment of hazards from carcinogens and cocarcinogens used or proposed to be used as food additives or pesticides". The report of this panel has now been approved by the Committee, and is reproduced below.

REPORT

Terms of Reference

This Panel was charged with "the assessment of hazards from carcinogens and cocarcinogens among substances used or proposed to be used as food additives or pesticides".

In the course of its deliberations the Panel found it necessary also to take note of other food contaminants besides pesticide residues.

Introduction

Substances taken by mouth can exert a carcinogenic action. The mechanism of carcinogenesis is complex, as chemical, physical, genetic, viral and other factors may be involved, so the planning, execution and interpretation of tests for carcinogenicity are complicated and must be carried out under scientific supervision.

Definitions

The Panel adopted the following definitions:

"A carcinogen is a substance which, administered by any route, increases the incidence of malignant neoplasms in animals or man."

> "A cocarcinogen, now more precisely called a 'promoter', is a substance which is not necessarily carcinogenic itself but which when applied to an animal together with, or after, a carcinogen or an 'initiator' increases the incidence or accelerates the appearance of neoplasms."
>
> "An initiator is a substance which is not necessarily carcinogenic itself, but which when applied to an animal before, or together with, a 'promoter' increases the incidence or accelerates the appearance of neoplasms."
>
> "A food additive is a substance added intentionally to food, generally in small quantities, to modify appearance, flavour, texture, storage or other properties."
>
> "A food contaminant is a substance which is not added intentionally, but may find its way into food by various means as, for example, pesticide residues, oil from machinery, material dissolved from containers."

Cocarcinogenesis

The Panel decided that insufficient evidence was at present available for it to express any opinion about hazards to man from initiators or promoters.

Listing of Permitted Substances

The Panel supports the principle of permitted lists as advocated in the First Report of the Joint FAO/WHO Expert Committee on Food Additives (W.H.O. Tech. Rep. Series No. 129). The Panel understands that the Preservatives Sub-Committee of the Food Standards Committee of the Ministry of Agriculture, Fisheries and Food have followed this principle in their reports, but that some of the substances included in the various permitted lists may not have been adequately tested for carcinogenic activity.

Testing for Carcinogenicity

The need for carrying out tests for carcinogenicity must always be considered when the safety of food additives or food contaminants is being scrutinised. The Panel is agreed that no short-term tests can yet be regarded as reliable for this purpose. The Panel, therefore, considers that all substances proposed for use as food additives should be subjected to tests for carcinogenicity along the lines indicated in an Appendix to this Report. The technique for testing food contaminants should follow a similar pattern.

The Appendix is not presented as a schedule to which all tests for carcinogenicity should exactly conform, but it should serve as a guide and an indication of the extent to which the Panel considers such tests should be carried out. Experiments and investigation may show that the tests indicated in the Appendix should be modified and possibly simplified, but much further research is needed on the design of tests best suited to demonstrate a carcinogenic effect.

Some food additives already in use have not been adequately investigated from the point of view of carcinogenicity and their testing is a matter of urgency. The retention of such substances on a permitted list should be reconsidered if they remain untested after a suitable interval (say 5 years). Certain additives including normal body constituents such as sodium bicarbonate or acetate might be exempted from further testing. Such substances should, however, conform to appropriate specifications if they are to be used as food additives.

Assessment of Evidence

Adequate data must be available about each substance in order to decide whether it should be regarded as a carcinogen according to the definition adopted in this Report.

Given such data the responsibility for deciding whether any particular substance as a food additive or a food contaminant constitutes a carcinogenic hazard to man should be entrusted to an appropriate scientific Standing Committee. This same Committee should keep the whole problem under review and make such modifications in the recommendations below as may seem desirable in the light of experience.

Recommendations

(a) As a general principle, no substance shown to be a carcinogen when administered orally to animals should be added to or allowed to contaminate food.

(b) If a substance is shown to be a carcinogen to animals by any other route of administration, or if it attracts suspicion of carcinogenicity solely on clinical grounds, the scientific Standing Committee mentioned above should decide whether, as a food additive or contaminant, it constitutes a carcinogenic hazard to man.

(c) Support should be given to research studies in this field which may have a bearing on the prevention of cancer.

(11 signatories)

A guide to the screening of chemicals for carcinogenic effect is appended to the original report.

(Monthly Bulletin of the Ministry of Health and the Public Health Laboratory Service, July 1960, 19.)

AEDES AEGYPTI ERADICATION IN BRAZIL

During the present century yellow fever has been greatly reduced as a public health problem; the development of effective methods of control has been made possible by the elucidation of the etiology and epidemiology of the disease. The campaigns against yellow fever in the Region of the Americas are especially interesting, not only because of the nature of the problem in that Region but also because of the kinds of international collaboration instituted to deal with it.

The most effective way to control urban yellow fever is to eradicate *Aedes aegypti*, the mosquito vector of the disease. Against jungle yellow fever the only effective weapon as yet is vaccination.

Size and climate made Brazil the American country most infested by *A.aegypti*, and the fight against this vector has been going on there since the beginning of the century. Up to 1931 the campaign was carried on in a rather desultory fashion, but with the coming into force of the Regulations of the Yellow Fever Service a basis was established for the organization of the control measures that were to culminate 24 years later in the eradication of the mosquito. These regulations made it possible to apply oil to all domestic water containers used by the mosquitos as breeding places and to fine property owners for failing to comply with the orders of the Yellow Fever Service.

In Brazil from 1933 to 1937 the first great eradication campaign that had been waged against the insect vector of any disease until then was waged against *A.aegypti*. Improved methods were adopted and applied by a country-wide service with great efficiency. Until 1940 the direction of the campaign was entrusted to the Rockefeller Foundation; in that year the Brazilian Government assumed full charge, and the eradication of the mosquito from its last refuges was attained by purely national efforts.

In 1940 the great importance of the resistance of the eggs of A.aegypti to desiccation for months on end was recognized. Near Rio de Janeiro it was observed that the mosquito was breeding in rot holes in orange trees; thousands of these holes had to be found and filled with cement. A much more important problem was the reinfestation by A.aegypti of localities on the banks of the big rivers, particularly the Parana river system, by boats coming from countries without control services against the mosquito. This showed the need for the campaign to be carried out internationally.

By 1947 A.aegypti infestation had been confined to the rural portions of the north-eastern part of Brazil. This raised the hope that eradication of the mosquito from the whole country would soon be achieved.

The availability of DDT with its lengthy residual action greatly hastened the fulfilment of this hope. In March 1955 the country's last A.aegypti were found, in a very isolated place in the State of Bahia. Brazil has now the great satisfaction of having completely protected a huge section of its population against all risk of yellow fever, and of having by its experience contributed to the successful outcome of similar campaigns in all the other countries of the Americas, and elsewhere.

Brazil is a huge country, with a total area of 8,469,885 km^2, a very large part of which was originally infested with Aedes aegypti. An area of 8,270,297 km^2 was surveyed for the mosquito, which was found in 244,366 of the 4,720,439 habitations originally inspected. Of the 1894 municipios (counties) into which Brazil is divided, 1882 were surveyed and A.aegypti was found in 1187. In 961 of these eradication was achieved with oil, leaving only 226 to be cleaned up with DDT. Of the 268,576 different localities surveyed, 35,119 were found to harbour the mosquito. From 1931 to 1957, a total of 617,021,537 house visits were made, and 3,414,210,354 water containers were inspected.

Early in 1958, in its capacity as co-ordinator of the campaign for the eradication of A.aegypti from the Americas, the Pan American Sanitary Bureau, which acts as the WHO Regional Office for the Americas, accepted the invitation of the Brazilian Government to send two consultants to Brazil to make a spot check for the presence of the mosquito. It was obviously not possible to survey all the areas previously infested, and, in view of the time that had elapsed since the last focus had been found and the number of routine checks made in the areas of low infestation, the survey was limited to the eastern and north-eastern states of Brazil, where the rural infestation has been greatest and the eradication operations most difficult.

The PASB consultants supervised the work of 24 experienced Brazilian inspectors. In 20 weeks the team inspected 72,478 dwellings in 1,165 localities in 102 municipalities. Not a single A.aegypti was found.

The XVth Pan American Sanitary Conference, held in Puerto Rico from 22 September to 4 October 1958, examined the reports submitted by Brazil and ten other countries regarding the eradication of A.aegypti, and concluded that the mosquito had been eradicated from all of them. The Conference appealed to all the other countries of the Americas that still harbour A.aegypti to intensify their eradication programmes.

(WHO Chronicle, 1960, 14, (6), 225-6.).

AGRICULTURAL RESEARCH IN THE UNITED KINGDOM

1. Properties of Insect Cuticle and Egg Shell - "Waterproofing": This subject was early selected for detailed study, because these properties determine both the survival of the insect in the dry terrestrial environment in which it lives, and the penetration of insecticides. It was found that the waterproofing of the cuticle is dependent upon a thin layer of wax deposited on the surface. The wax is much harder and has a higher melting point in those insects which are most resistant to desiccation. If the temperature is raised a point is reached (somewhat below the melting point of the wax) at which there is a more or less abrupt increase in transpiration. It was also shown that the wax is protected by another layer, termed the "cement layer", poured out over its surface from the dermal glands. But in spite of this, the impermeable layer is readily injured if the insect moves in contact with fine dusts or if it burrows in the soil. Insects abraded in this way lose water very rapidly when they are exposed to dry conditions, and they show an increased sensitivity to insecticides applied to the surface of the body.

The extension of this work to the insect egg shell showed that the same general factors are concerned in waterproofing. The impermeable waxes, however, are commonly laid down, not by the mother over the surface of the egg, but by the oocyte itself as a very thin layer on the inside of the shell. In the fruit tree red spider mite, on the other hand, the main factor in the highly efficient waterproofing of the egg is a layer of a peculiar waxy substance discharged over the egg by the female during oviposition. A rather different type of waterproofing grease is similarly added to the eggs by the female of the sheep tick Ixodes. The respiration of these exceedingly waterproof eggs if often provided for by a limited number of perforations which lead into an air-filled sponge with submicroscopic cavities that lines the inside of the shell.

The cockroach differs from most other terrestrial insects in having a mobile soft grease which forms the waterproofing layer. This grease consists, in fact, of quite hard waxes in a volatile solvent. On exposure to the air the solvent slowly evaporates leaving a hard wax.

Doubt has been cast by some authors on the reality of the abrupt change in permeability of the wax layer when the temperature is raised. But during the past year an improved apparatus has been devised for the accurate control of temperature and for the measurement of temperature at the actual surface of the cuticle. By this means it has been proved that the increase in permeability at the critical temperature is in fact much more abrupt than had previously been supposed. Furthermore, there is a secondary thin layer of wax which lies on the outer surface of the cement layer. This covering has a higher critical temperature than the primary wax layer and it adds greatly to the efficiency of the waterproofing system.

2. Movement of Toxic Substances in Plants: A compound which has penetrated the leaf surface is dependent for its subsequent distribution upon cell to cell movement, translocation in the phloem and transport in the xylem. Movement of growth regulators in undifferentiated tissue has been investigated in some detail and it is evident that the extent of movement and the amounts moved are linked with the chemical structure. Other experiments have shown that the ability of different types of herbicides to move out of the treated leaf are widely divergent. Some compounds within a short time are present throughout the rest of the plant while others remain within the leaf.

These basic studies are now being followed up by field investigations to ascertain to what extent and under which conditions herbicides applied to the leaves are transported to the underground systems of perennial weeds. Two species have been selected for the initial programme. Agropyron repens (couch grass) and Pteridium aquilinum (bracken), while the principal compounds being employed are 2,2-dichloropropionic acid (dalapon) and 2,4-dichlorophenoxyacetic acid (2,4-D). In addition other experiments, more particularly with bracken, have been laid down to test the influence of time of application, compound, dose and formulation on the degree of control.

3. Virus Research: One problem of considerable interest which is being investigated is the nature of the changes which occur when the "cowpea" virus (related to tobacco mosaic virus) is grown on different hosts. The most obvious change is the replacement of a lysine residue in the protein by a histidine residue when the virus grows on Phaseolus vulgaris as opposed to tobacco. A more detached study of this phenomenon is being undertaken, and is being supplemented by similar experiments using other viruses.

The polyamine present in several plant viruses is being examined with a view to establishing its constitution and function. Model experiments using spermidine, which is closely related to the unknown amine, have shown that these substances have a profound effect on the physical properties of some viruses.

4. Soil Bacterium Studied: Studies on breakdown within the plant of acids related to plant growth substances have continued and the investigations have now been extended to include bacteria. A bacterium isolated from soil has been shown to be capable of degrading substances of this type in the same way as they are broken down in the plant. These findings have led to studies on selective bactericidal action. In other work, naturally occurring gibberellin-like substances have been extracted from plant tissues and the role played by this group of substances in cell physiology is being investigated.

5. Organophosphorus insecticides are generally considered to act by affecting cholinesterases, and most of them do affect these enzymes. However, that it may not be the only way all of them act was suggested by the fact that poisoning house flies with diazinon had no effect on the cholinesterase activity of their brains. The mechanism whereby flies become and remain resistant to diazinon seems to differ with different strains: one resistant strain remained resistant from generation to generation without being continually exposed to the poison, whereas another remained resistant only when each generation was exposed.

(Report of the Agricultural Research Council for the Year 1958-59. London H.M.S.O. Cmnd.1069).

SOME PEST CONTROL RESEARCH TOPICS AT LONG ASHTON

Aldrin - Mode of Action: The symptoms of poisoned insects indicate a mode of action different from that of DDT, although the sequence of events - inco-ordination, paralysis, and death - is superficially similar. The oxygen consumption of the adult showed a sudden increase to approximately five times the normal rate, after a latent period of several hours or days, according to the dosage; this was followed by a slow decline until death. This is similar to the results obtained with DDT and shows a strong correlation between the respiration rate and the insecticide-induced activity of the insect. The respiration, measured as oxygen uptake, of thoracic ganglia from DDT-poisoned insects showed a change of rate with change of activity similar to that of the adult, the maximum ganglia respiration being double the normal rate. Only a slight increase was found in the respiration rate of thoracic ganglia from insects poisoned with aldrin. It would appear that an increase of the respiration rate accompanies the action of aldrin but it is less than that induced by DDT and not so definitely correlated to the activity of the adult. Increased oxygen consumption occurs also in the latent period before symptoms appear.

Pyrethrum Aphicidal Spray: Emulsions of extracts containing 0.0025% and 0.005% pyrethrins were compared with those of DDT alone applied at 0.025% and a combination of DDT/BHC (0.025% DDT/0.007% gamma BHC). The emulsions were formulated similarly with solvent naphtha and sulphite lye emulsifier; all the sprays were used with 0.025% Manoxol N. The sprays were applied to full coverage by hand-lance to Cox trees at the green cluster and pink bud stages. A complete control of aphids was obtained with each emulsion applied at each stage, whereas on unsprayed trees the percentage of flower trusses infested was 59. Further work is in progress to assess the value of pyrethrum and other materials when applied by small volume spraying methods.

Effect of Surface Active Agents on Spray Deposition: Spray deposition is influenced by the physical and chemical reactions that take place between the surface-active agents and the leaf surface. Typical recoveries of a tracer dye dissolved in the oil phase of an emulsion sprayed to complete wetting on apple leaves were: anionic wetter = 0.150/ug/sq.cm; non-ionic wetter = 0.200/ug/sq.cm; cationic wetter = 0.350/ug/sq.cm on leaf. Unlike the anionic and non-ionic wetters, small changes in structure or concentration of cationic wetters have a marked effect on the amount of deposit.

Hand Canister Sprayer: A brass pneumatic hand canister sprayer has been designed for the spraying of coconut spadices by climbers. The canister is pumped-up by a foot pump and fitted with a safety valve, wide-angle flat spray nozzle, thumb-operated release tap and a clip for easy attachment to a waist belt. Every item of the sprayer was made for easy operation and to withstand rough usage; the total weight was 3 lb. Twenty-four were made for experimental work in Kenya.

Spray Application Problems:

1. Uptake of Mercury by Plant Tissues: Experiments on the penetration and distribution within plant tissues of mercury applied as phenylmercuric acetate are described. Absorption occurs within a few days from the surfaces of apple leaves and fruits: some is firmly held in the cuticles of the fruits and some appears in the flesh. Mercury is taken up by the roots of plants from nutrient solution or soil, but little is translocated to the tops. The results of the examination of the curds and roots of broccoli plants treated at the seedling stage with calomel or mercuric chloride are reported and the natural mercury content of fruits and vegetables is discussed.

2. Persistence of Lonchocarpus Deposits on Plants: Chemical assay of lonchocarpus deposits on plants in the field showed that under dull, cool conditions, with no rain, insecticidal compounds persisted for at least one week, and that under conditions of bright sunlight and high temperature the toxic compounds were quickly lost.

3. Limits of Visibility of Fluorescent Tracers: In all formulations, using tracers at or below normal field concentrations, droplets of 50-80 microns diameter are visible by eye and droplets of 20-30 microns diameter can be seen by microscope.

(University of Bristol. The Annual Report of the Agricultural and Horticultural Research Station, Long Ashton, 1959.)

VETERINARY RESEARCH, WEYBRIDGE.

Warble Fly: Since 1956 there has been rapid progress in the development of systemic insecticides for the control of Hypoderma, the warble fly. One of the more promising organo-phosphorus compounds, Dow ET 57, was used in Ministry field trials in the winter of 1957-1958 and the results were sufficiently encouraging for more extensive trials to be carried out this winter, paying special attention to the effect of the drug on different stages of larval migration through the body of the host.

In the laboratory, warble larvae were removed from cattle and implanted into rabbits. Dow ET 57 was then administered orally in an attempt to discover at what stage, and how rapidly, the chemical acts on the parasite. As Dow ET 57 has strong anti-cholinesterase activity it is hoped to trace the action of the insecticide on implanted larvae by estimating the amount of unchanged cholinesterase in larvae following dosage of the host with various concentrations of drug.

Control of Liver Fluke: The attempt to prove that it was possible to control, on an economic and practical basis, acute fascioliasis on a "flukey" farm in Anglesey which was begun last year has been continued. In 1957 one application of copper sulphate was given and no losses were recorded. The following year an application of copper sulphate in May and one of 'Santobrite' in September were given. One ewe died of acute fascioliasis, a reasonably satisfactory result in view of the fact that in 1954, a similar year to 1958, losses totalled 123 out of a flock of about 350.

The use of 'Santobrite' (sodium pentachlorophenate) as a molluscicide is an innovation in this country; it was sprayed on to habitats at the rate of 10 lb in 30 gallons of water per acre. At this rate of application the total cost of materials and labour was less than that used for applying copper sulphate at the rate of 28 lb per acre. In this instance the total costs using hired equipment were just under £25. If a more adaptable spraying unit were used the cost might be reduced to under £20.

Sheep Blowfly Eradication: During the early summer a test was made of the degree of reduction of the *Lucilia sericata* population on Holy Island as a result of the intensive liberation of sterilised specimens during 1956 and 1957. On ten occasions during July a group of 20 crossbred lambs on the Island, with a similar group on a farm on the adjacent mainland, were made attractive to *L. sericata* by chemical treatment. A total of 35 egg clusters, involving 22 sheep, was obtained on the Island, whereas only four clusters (four sheep) were obtained in the control flock. The low incidence in the control is anomalous, as under normal conditions the method is a reasonably effective way of obtaining oviposition; it is, however, obvious that a considerable population still exists on the Island. The unexpectedly low frequency of oviposition on the adjacent mainland is at present inexplicable.

In a trapping experiment with distinctively dye-marked flies in August, four groups, each numbering about 4,000 were released at points about a mile apart along the coast opposite the Island; a fifth group was released on the Island. Recovery trapping was carried out over the next fortnight. Of the 3,800 Island releases, 271 were recovered on the

Island, together with 859 unmarked, i.e. presumably native L. sericata indicating a native Island population in the order of 10,000 to 15,000 flies. This result confirms the conclusion, from the attractant testing, that no reduction of the Island population had occurred.

Insecticides in Sheep Dips: The determination of solubilities and rates of diffusion of chlorinated insecticides in lanolin was mentioned in the 1956 Annual Report. Further work along similar lines has shown that the differences in respect of these properties between the various insecticides studied are insufficient to account for observed differences in the rates of depletion of insecticidal emulsions on fleece. Studies of the behaviour of such emulsions when allowed to percolate through columns of glass wool impregnated with lanolin have confirmed that lanolin plays the central role in the uptake of insecticides by natural wool, and have shown that the tendency of dips to be stripped of insecticide during dipping can be readily estimated by straightforward laboratory experiment.

It was found that sheep dipped in a BHC-dieldrin emulsion dip in August, 1956 still had enough insecticide left in the outer part of the wool to kill many of the Lucilia larvae placed in contact with it in laboratory tests. Under normal conditions this wool would have been sheared off in 1957, but it is interesting to note the degree of resistance to weathering possessed by the bond uniting insecticide to wool fibre. The dieldrin-wool linkage withstands prolonged chemical action with dieldrin solvents and its nature remains uncertain.

(Ministry of Agriculture, Fisheries and Food, Department of Agriculture for Scotland. Report on the Animal Health Services in Great Britain, 1958.).

PEST CONTROL IN SCOTLAND

Fumigation Measures: Ships and their cargoes continued to be inspected at Scottish ports and a total of 60,180 tons of imported goods were fumigated on the Department's recommendations. Some 15,000 empty sacks were also fumigated. The list of exporting countries to which reports on infestation in cargoes are sent was extended to include Cyprus.

Methyl bromide was increasingly used for the fumigation of mills by servicing companies. An oatmeal mill and four flour mills were treated, two for the second time. Even where a high degree of success was not expected, because of the difficulty of sealing, the practical results were better than those previously achieved with hydrogen cyanide.

Five 'spot fumigations' of milling machinery were carried out by the Department or under their supervision. This method has now been shown to be capable of controlling infestation but more needs to be known about the amount of fumigant escaping from the machines so that the possible dangers, when its use is not closely supervised, can be assessed.

During the year three silo-bins of infested wheat were treated experimentally with phosphine, and the experience gained in this method of application was useful. Satisfactory results were obtained from using phosphine to fumigate a small stack of meal under a sheet.

(Agriculture in Scotland. The Report of the Department of Agriculture for Scotland for 1959. H.M.S.O. Edinburgh.).

STUDIES RELEVANT TO THE CONTROL OF PESTS SCIENTIFIC RESEARCH IN BRITISH UNIVERSITIES 1959-60.

Details are substantially the same as those given in previous summaries (viz. P.A.N.S., 'A', 1959, 5, (3), 299-302; Ibid. 5, (4), 435. An additional entry from Nottingham University is noted:

NOTTINGHAM UNIVERSITY

Department of Agricultural Zoology

J.Y. Ritchie	Biological problems of Aphididae with particular reference to infestation and movement.
W.N. Yule	Studies of the biological properties of pyrethrum formulations for use against pests of horticultural crops.

RECENT DEVELOPMENTS IN PEST CONTROL IN THE U.S.A.

(1) New Laboratories for the U.S.D.A. Agricultural Research Services: Four new laboratories are being constructed for U.S.D.A. research. Three will be used for expanded studies on control of cotton and grain insects; the fourth will provide modern facilities for crop research.

State College, Miss., is the site of the $1,100,000 laboratory where a team of research entomologists, chemists, plant breeders, an agricultural engineer and a farm economist will concentrate studies on new approaches to control of the boll weevil and other cotton pests. Much of the work will be basic research.

Scientists at the Brookings, S.Dak., and Tifton, Ga., laboratories will engage in an all-out effort to develop more effective control methods for the corn borer, corn earworm, fall armyworm, rice weevil, and other insects attacking grain. The laboratories will each cost $550,000.

New facilities at Logan, Utah, will furnish space for the transfer from Salt Lake City of research on sugarbeet breeding, quality, production, and diseases, as well as nematode control in sugarbeets, fruits, and forage crops. The $600,000 laboratory will also provide room to accommodate present experimental work at Logan on alfalfa, grass, range reseeding, legume-seed production, and safflower.

(Agricultural Research, July 1960, 9, (1).)

(2) New Control for Plum Curculio: Treating the soil under peach trees with insecticides controls the plum curculio and may eventually replace tree spraying according to U.S.D.A. entomologist, O.I.Snapp.

The adults of the plum curculio, Conotrachelus nenuphar, winter in trash or other protected places in and about the orchards. They normally move to the trees about flowering time. These adults later lay eggs in the newly set fruit. The eggs hatch into grubs that feed in the fruit until full grown, then leave the fruit and enter the soil to complete their development. When an insecticide was mixed with the top layer of soil early in the spring in tests at Fort Valley, Ga., the subsequent broods of larvae were killed.

Aldrin, dieldrin, and heptachlor were equally effective in the tests, one application preventing successful emergence of plum curculio adults for several years. In one field test, aldrin granules were spread under Elberta peaches trees in March 1957, and no further treatment was given. Only 1.6% of the harvested fruit was infested in 1957, 2.9% in 1958, and 0.7% in 1959. Some of the infestation may have come from Beetles outside the treated orchard. Aldrin was mixed with fertilizer and spread under several thousand trees in March 1958, in a cooperative experiment with a Georgia peach grower. The material was broadcast by hand and disked into the ground. No wormy peaches were found in the 1958 harvest and in 1959 the owner found wormy fruit in only one small area of the orchard. In contrast, peaches in a neighbour's untreated orchard were ruined by the pest.

The plum curculio also attacks plums, cherries and apples.

(Agricultural Research, June 1960, 8, (12).)

(3) Orange Tortrix, *Argyrotaenia citrana* Fern.: This pest on apples in California usually has been controlled satisfactorily by the use of TDE in the codling moth schedule of treatments. However, the recent increase in cases of codling moth resistance to TDE, and to DDT, has caused some growers to change to other insecticides, although little is known about the effectiveness of the substitute compounds against orange tortrix.

The orange tortrix is almost as important a pest as the codling moth. The orange tortrix is a surface feeder, but the shallow bites the pests take in the calyx, stem, or the sides of the fruit make the fruit unsuitable for fresh shipment and rejected by most processors except those engaged in producing juice.

To evaluate several new compounds against the orange tortrix, a test plot was established in a Yellow Newtown Pippin orchard near Watsonville. The Yellow Newtown Pippin is an apple variety especially susceptible to orange tortrix because of the short fruit stem and the tendency for the fruits to touch. The larvae of the orange tortrix usually spin webbing in sheltered places provided by the closeness of the fruits and feed from within this protection.

The orchard chosen for the trials suffered considerable damage from orange tortrix during 1958. In the winter of 1958-59, the larvae found feeding within mummified fruit on the trees were so numerous they indicated a potentially damaging population for the fruit season.

Orange Tortrix Test Plots in Yellow Newtown Pippin Apples, Watsonville, 1959.

Material	Dosage per acre [ø]	Infested fruit %
TDE	10.6 lb 50% WP [øø]	0.5
Sevin	7.6 lb 50% WP	1.8
Methyl Trithion	10.6 lb 25% WP	6.5
Ethion	10.8 lb 25% WP	10.3
Ethyl Guthion	7.7 lb 25% WP	11.3
DDT	10.4 lb 50% WP	15.3

[ø] Application dates: May 5, June 11, July 28.
[øø] WP: Wettable powder.

Materials chosen for trial, 'Guthion', 'Sevin', 'Ethion', and 'Trithion', had shown promise in previous codling moth trials. TDE was used as the standard insecticide and DDT was used as a check because it is not effective against orange tortrix. The ethyl formulation of 'Guthion', rather than the methyl form, and the methyl form of 'Trithion' instead of the standard ethyl formulation were used.

Each treatment was applied to four trees with two replications in a randomized block plot design. Materials were applied with a conventional high pressure rig and orchard spray guns at an average of 500 gallons per acre per spray. In an attempt to time the treatments, bait pans and a light-trap were used to capture adults, but so few were trapped the sprays were timed according to the local standard codling moth schedule. At harvest, the test plots were evaluated by examining 300 fruits per replicate picked at random from the treated trees. Fruits with typical orange tortrix feeding scars were recorded as infested.

TDE gave the best control in the Watsonville experiment and 'Sevin' was the only one of the other compounds that yielded commercial control. Ethyl-'Guthion', methyl-'Trithion' and 'Ethion' did not prevent damage in excess of the generally accepted economic level of 5% infested fruit.

During the experiment, the compounds were studied for their effectiveness on other pests. Ethyl-'Guthion' and 'Ethion' provided good control of European red mites, but it was necessary to add an acaricide to the other materials for the June spray.

A light infestation of codling moth was noted on the fruit treated with Methyl-'Trithion' and 'Ethion'. None of the other plots showed any codling moth damage. Apple aphid and woolly apple aphid were present, but infestations remained at a low level because of extremely hot weather during June and July. The DDT and the TDE plots were the only ones to show a potentially damaging aphid population, and an aphicide was added to the June 11 treatment.

Fruit treated with Methyl-'Trithion' showed russet spots on the skin beneath the dried spray droplets, but injury was superficial. None of the other compounds gave adverse effects.

(H.F.Madsen & L.A.Falcon, California Agriculture, 1960, 14, (4).)

(4) Chemical Specialities Manufacturers Association - 46th Annual Meeting: Papers presented by the Insecticide Division at the 46th Meeting reflected the wide interests of its members, the special theme being that of spraying equipment.

Cockroach Poisons on Various Surfaces: (1) It is reported that a formulation containing 1.0% malathion and 0.5% dieldrin gives results equal to or exceeding that of all other materials tested when applied to glass and masonite panels. However, this formulation showed very little mortality on asphalt tile. Methoxychlor and lindane gave good results on glass, but only fair results on masonite. Mortality results with DDT were consistently low on all three types of surfaces. Chlordane, malathion and 'Korlan' gave very similar results. In fact, these three insecticides, when tested individually on asphalt tile, gave results higher than the combination of insecticides tested on the same panels. 'Korlan' gave results comparable to those of malathion when tested at the recommended concentration. At times it indicates an initial kill slightly higher than malathion; however, the residual activity may not last quite so long.

Musca autumnalis DeGeer, Livestock Pest: McDuffie (2) reports that, in Ohio, the fly was controlled for 8 days with 0.5% 'Co-Ral' applied all over cattle. Good control was also obtained for several days with a pyrethrum-repellent preparation. However, other pyrethrum-synergist formulations, malathion, DDT, and toxaphene were ineffective or reduced populations for only a few hours. He advises, however, that new materials and methods are needed to combat this pest. It is possible that house fly baits, especially of the paint-on type, may be adapted for use against this fly. Residual treatment of adult resting places as well as animal hosts should be explored further. Feed additives, especially insecticides with systemic action, should be tried as a means of killing adults and preventing breeding in manure. These are only a few possible approaches to the solution of the problem. Research workers will doubtless come forward with many others and eventually provide a satisfactory method of controlling this fly.

Bacillus thuringiensis Berliner: B. thuringiensis, states the author (3) "is not a cure-all". It works well on many Lepidoptera larvae, the chewing worms, like tobacco hornworm and cabbageworms. These worms stop feeding and drop off the plants. They apparently do not even recover from paralysing, but initially sublethal, does of the spore/crystal combination. It is a stomach poison in that it has to be ingested by the insect. At least until we have better knowledge of the distribution and adherence of the dusts and sprays, control appears to be dependent on getting an effective coverage of the plant. If such sprays and dusts have any effect on other insects it is generally at much, much higher rates of application, with a different type of effect.

Insect Attractants: According to the author (4) more than 15,000 chemicals have been screened against 15 insect species. Methyl eugenol which attracts the oriental fruit fly (Ceratitis capitata (Wied.)) is reputed to be the most powerful synthetic insect lure known. In the Beltsville laboratories of the U.S.D.A. a series of related compounds have been made, and although none were as good as methyl eugenol, it is noted that this insect is attracted to compounds containing methoxyphenyl and ethoxyphenyl groups. The second compound, anisylacetone, was until recently the best melon fly (Dacus cucurbitae Coq.) lure. It has a serious defect in that it attracts melon flies only after they mature sexually - about 12 days after they emerge from pupation. Other compounds structurally similar to anisylacetone are brand-new lures for the melon fly. Not only are they much more potent and persistent than anisylacetone, but they attract even newly-emerged flies. The advantage of detecting and controlling an insect before it has a chance to mate is obvious.

While efforts to determine the gypsy moth's natural sex lure have gone forward, attempts to find a synthetic lure for this species by volume screening have not been neglected. Indeed it has been found that 1,2-hexadecanediol and 1,2-epoxyhexadecane, attract the male moth but not so strongly as the natural sex lure. These compounds are closely related to the sex lure of the silkworm moth which Butenandt et al. reported to be 10,12-hexadecadien-1-ol. The fact that the three lures for Lepidoptera are straight-chain compounds containing 16 carbon atoms may be of some significance.

Spraying Equipment: Particulars with some illustrations are given of spraying and dusting apparatus for garden, lawns, parks and recreation areas (5), and of mill and industrial sprayers (6). This is followed by a short account of household, dairy and livestock spraying equipment (7).

References

(1) R.W. Whiting, (2) W.C. McDuffie, (3) J.M. Merritt and M.A. Manzelli, (4) M. Beroza, (5) D.P. Lewis, (6) W.L. Brehm and (7) T.B. Welch.

(Proceedings of the 46th Annual Meeting of the Chemical Specialties Manufacturers Association including Committee Reports, December, 1959, Washington, D.C.).

NEWS ITEMS FROM THE COMMONWEALTH

AUSTRALIA

Blowfly Studies: The odour of a liquid medium containing powdered milk and yeast stimulated *Phormia regina* to oviposit. In the presence of a sufficient odour, contact stimulation by the same medium does not increase egg laying. The main receptors of the odour are located on the antennae and palps. Evidence was also obtained for olfactory reception by the ovipositor. Vapours given off by a mixture of indole and ammonium carbonate elicit oviposition by *Lucilia cuprina* in the absence of any contact stimulus. Indole vapour alone and carbon dioxide alone stimulate female flies to oviposit, but ammonia alone has little or no effect.

Phormia fed on glucose, fructose, or mannose are less active than flies starved for 24 hours after feeding on 0.1 M sucrose. Metabolic state and blood sugar concentration are not determinants of activity; nor is the mechanism identical with that by which feeding and starvation control the taste threshold. Locomotor activity is a function of crop volume and hence, perhaps, of the rate of crop emptying.

Using the larval implant technique, small-scale tests were made on 'Sevin' (1-naphthyl *N*-methylcarbamate) and two organic phosphorus insecticides, 'Rogor 40' and 'Dicapthon', for prevention of sheep blowfly strike. 'Sevin' permitted some larvae to survive eight days after treatment, and both this and 'Rogor 40' allowed larvae to survive in most implants 29 days after treatment. 'Dicapthon' still afforded a high degree of protection 78 days after treatment.

Indirect evidence is available that gravid females of *Lucilia cuprina* are deterred from ovipositing by the presence of diazinon on fleece. This leads to oviposition selectively on any areas missed during application. Direct evidence for this process has now been obtained from insectary trials, and these underline need for thorough application of the insecticide.

Cattle Tick: The toxicity of 'Bayer 21/199' in dipping vats declines as the fluid ages, and as contamination increases from dirt and cattle dung. Measured amounts of soil and dung were added at fortnightly intervals to a dipping vat charged with 0.05% 'Bayer 21/199'. The toxicity of the fluid to ticks declined, and the deposits of 'Bayer 21/199' left on cattle hair showed a marked fall.

A further attempt was made to determine the end products of breakdown of gamma-BHC in a sample where the gamma-BHC had lost 4-5 atoms of chlorine. The chlorine split from the BHC was detected as chloride and, using chromatographic methods, an organic chlorine breakdown product - as yet unidentified - was separated.

Observations were made on a number of dipping vats containing mixtures of DDT and an organic phosphorus compound. Use of these mixtures appears to have advantages over use of either of their components. Fluorinated compounds were tested as acaricides, but the dosage required to kill ticks was too close to that toxic for cattle. A number of chemicals were screened as acaricides by spraying approximately half the escutcheon of tick-infested cattle with a small CO_2-operated spray, leaving the remainder of the escutcheon untreated for comparison. Spraying with 'Bayer 21/199' was reported overseas to produce systemic effects on ectoparasites on unsprayed areas. Beef dripping and lanoline saturated with a high concentration of 'Bayer 21/199' were applied by felt-padded belts to tick-infested cattle. No systemic effect was detected on ticks in areas not in contact with the belts.

Liver Fluke: Further studies were made on the bionomics of Simlimnea subaquatilis. The optimum temperature for the reproduction of these snails is 24-26°C. They can produce egg masses at the usual temperatures found in their habitats during winter but hatching is delayed until the spring. They can aestivate in mud for at least eleven months under field or laboratory conditions.

In vitro experiments with copper sulphate, copper pentachlorophenate, sodium pentachlorophenate, zinc sulphate and zinc pentachlorophenate, showed that copper sulphate and copper pentachlorophenate were the most lethal to snails and their egg masses. Both the delta and gamma isomers of BHC were inefficient.

Orchard Pests : 1) Queensland Fruit Fly: Experiments on dispersal of adults in orchards and in areas of dry bushland have indicated that rate of dispersal in the species is quite low. There is probably a high mortality in flies released in dry bushland. Immature adults appear to disperse from orchards more rapidly than mature adults.

2) Red Scale, Aonidiella aurantii, can be killed on oranges by heat treatments varying from 50 to 70°C. No killing occurs in air temperatures of 35 and 40°C, but does occur at 45°C with long time interval. Tests in a water bath at 1°C intervals from 40 to 50° C with an immersion time of 8 min, had no significant effect

below 48° but gave 99% kill at 50°C. Tests on large trees covered by a tent suggest that it is possible to kill scale without damage to the tree but it is difficult to obtain adequate and uniform leaf temperatures.

Termite Control: The effectiveness is being studied of varying additions of chlordane or white arsenic to the glue line of karri plywood to prevent termite attack. All levels of both compounds so far tested have proved completely effective, and the threshold values necessary for protection are being established.

Laboratory tests have been made of various plastic gypsum plaster boards and insecticide-treated hardboards. With the latter product the high efficiency has been demonstrated of small additions of either aldrin or dieldrin. Both dense and "no-fines" concrete can be made termite proof by the addition of a small amount of dieldrin and this treatment is highly resistant to both leaching and volatilization influences.

Surface treatments have shown that 5% pentachlorphenol is the only treatment still effective against Nasutitermes exitiosus after three years.

Rodenticide Studies: The influence of weathering on carrots and oats treated with "1080" was investigated. A single fall of about 1 inch of rain made carrots non-toxic, but oats retained about half of the initial potency after three such falls over a period of nine weeks. Practically all of the residual toxicity was in the husks of the oats, and none was detected in the grain. Where rain may be expected, therefore, carrot is the bait of choice if it is desired to restock pastures quickly.

Research is continuing into poisons having some degree of specificity to rabbits. Sheep are relatively insensitive to dinitro-orthocresol ('Dinoc'), but its effect on rabbits is not known. Tests of mixtures of 'Dinoc' and '1080' are being made in the hope that the low pH of rabbit stomachs will permit un-ionized 'Dinoc' to exert its toxic action. Preliminary results are quite encouraging, indicating that the toxic effects of the mixtures are synergistic and not merely additive.

(Eleventh Annual Report of the Commonwealth Scientific and Industrial Research Organization for Year 1958-59.)

AUSTRALIA - QUEENSLAND

Linseed, Heliothis Control: *Heliothis*, which attack many cultivated crops, are primarily pests during seed production. The caterpillars, or grubs, cause damage in linseed by tunnelling into the capsules and feeding on the developing seed. When seasons are early, and also in late-planted crops, terminal damage is not uncommon before flowering. When present in large numbers *Heliothis* may cause almost complete loss of the crop.

The moths are stout-bodied insects with an average wing expanse of 1½ in. The forewings are coloured in shades of grey brown or pink and the hindwings in grey to grey brown with a large marginal smoky area. When disturbed, the moths have the peculiar habit of flying low and rapidly over the crop and alighting again within 50 yards. Each female is capable of producing large numbers of eggs, which are deposited singly on the growing points and flowers. Caterpillars hatch out after three to four days. *Heliothis* larvae crawl about the plants feeding on the buds, flowers and developing seed, although small larvae sometimes feed for days entirely within a boll. When fully grown, after 18 to 22 days, they measure up to 2 in. and are green to brown with varying degrees of black pigmentation. Grubs of different sizes may be found in a linseed crop but all belong to the one generation, being the progeny of the moths which emerge from the overwintering pupae. This emergence commences with the warm weather of early spring and may continue for 3 or 4 weeks.

Boom spraying, applying not less than 15 gal of spray to the acre, is the most effective method of *Heliothis* control in linseed. For best results, DDT, in emulsion form, should be used at the rate of 1 lb of active insecticide to the acre, irrespective of the volume of spray applied. If spraying is carried out soon after moths are active in the crop, and if most of the larvae are no more than ½ in. long, ½ lb of active insecticide to the acre is sufficient for commercial control.

(T. Passlow and A. W. S. May. Queensland Agricultural Journal, 1960, 86, (4), 219-221.)

Pineapples - Nematode Control: A problem facing pineapple growers in Queensland is that of declining yields, and fewer ratoons on replant land. Recent investigations have shown that these conditions are frequently attributable to the nematode complex associated with the roots. The important members of this complex are a root-knot nematode (*Meloidogyne javanica* (Treub.)), a root-lesion nematode (*Pratylenchus brachyurus* (Godfrey)), which feeds within the root cortex, causing premature breakdown of the fibrous roots, and a spiral nematode (Helicotylenchus nannus Steiner), which feeds externally, producing superficial lesions. The result of nematode infestation is a root system reduced in size and efficiency, a smaller plant and smaller fruit.

Control of nematodes in pineapples can be achieved by injection of a suitable fumigant into the soil either before or after planting. The treatments are as follows:

(a) Pre-plant treatment: Use either EDB (27% w/v or 12½% v/v)ø or DD at the rate of 25 gal to the acre for overall treatment or 17 gal to the acre for bed treatment. In the overall treatment the fumigant is applied over the entire area in rows 1 ft apart. In the bed treatment, injections are made in four rows 1 ft apart along each bed, leaving the interbed spaces untreated. In each instance the fumigant is applied at a depth of 6 to 9 in. For effective fumigation:

The soil should be well prepared, free of clods and undecomposed plant residues.

The soil should be moist, not dry, particularly in the lighter soil types.

The weather should not be extreme.

A roller should be used immediately after treatment.

The following points are pertinent when considering whether overall or bed treatment should be used:

For overall treatment, land preparation and fumigation can be carried out many months prior to planting, provided no weeds are allowed to grow for more than three weeks in the intervening period. Fumigation can be carried out when conditions are suitable for maximum effectiveness.

Bed treatment is less expensive. As growers bed up shortly before planting, a limited time is available for fumigation, and soil conditions may be unsuitable.

(b) Treatment of established plants less than eight months old: Nematodes on or near the roots of pineapple plants can be controlled with 'Nemagon' at the rate of 2 gal to the acre as a bed treatment. For small areas the fumigant can be applied by hand injector between the plants in each row; for larger areas by machine injector down the middle of the bed. The depth of injection should be 6 to 9 in.

ø Use other formulations of EDB at equivalent rates.

Pre-plant fumigation is more effective than fumigation after the plants have become established and infested with nematodes. Because considerable expense is involved and the nematode population in the soil could be insufficient to affect growth seriously, some growers may not be prepared to adopt pre-plant fumigation as a standard practice. As an alternative, it is recommended that every fifth bed be treated with EDB or DD prior to planting. If a marked response occurs within six months, the remaining rows should be treated with 'Nemagon'.

("Nematode Control in Pineapples". R. C. Colbran. Queensland Agricultural Journal, 1960, 86, (6), 386-8.)

AUSTRALIA - SOUTH

Two-Spotted Mite (Tetranychus telarius L.): Commonly known as red spider, it is a world wide pest of vegetables, garden plants and some kinds of fruit trees. In large numbers the mites can cause complete failure of the plants. In this way they may seriously reduce crop yields.

The adult spider mite has eight legs. It is only about 1/50th of an inch in length and its colour varies from green to red. There are two light grey spots on the back. Very small, round, semi-clear eggs are laid on the lower surfaces of the leaves of the host plant. One female may lay from 70 to 100 eggs in the course of its two to three week life. Hatching begins in four or five days under favourable conditions. The young mites have only six legs, but later they moult their first skin and become eight-legged like the adults. In warm weather mites may reach maturity in less than a week. From egg laying to adult, the life cycle may occupy less than 14 days. In South Australia there are several broods a year. Usually the adult female over-winters on grass or other ground cover. With the arrival of spring it again becomes active and lays eggs which give rise to the spring brood of the pest. However, it is the early summer (from November onwards) when two-spotted mite is most likely to cause trouble.

In order to combat two-spotted mite control measures must be carried out promptly. The following spray material may be used for control:

Kelthane - $1\frac{1}{2}$-2 lb per 100 gal water.
Trithion - 1 lb per 100 gal water.
Tedion - 1 lb per 100 gal water.

Tedion may be used where phosphate insecticide resistance exists. Other materials which may be used are "Ovotran", "Aramite", HETP, chlorobenzilate.

(R. G. Dent. Journal of Agriculture, South Australia, Apr. 1960, 63, (9), 399 et seq.)

CEYLON

Rubber, Disease Control:

(a) Oidium: The incidence of Oidium leaf disease was comparatively mild in most districts. Spraying with a wettable sulphur gave good results provided effective coverage of the foliage was obtained and this was achieved by carrying the machine along every other row in square-planted areas. Electrodusting showed no advantage over ordinary dusting for the control of the disease.

(b) Phytophthora: The incidence of *Phytophthora* leaf fall and of bark rot was the heaviest recorded to date and this was due in the main to the exceptionally long duration of the S.W. monsoon rains which extended almost continuously from May to mid-October, without the usual dry spell during August and September, and to the relatively low prevailing temperature, factors which were in favour of the development and spread of the casual fungus and against the regular, timely application of control measures.

Field experiments to compare different brands of copper-based fungicides and to compare dusting with spraying were carried out during the *Phytophthora* season. Experiments for the control of *Phytophthora* bark rot were also carried out. Promising results have been obtained with two chemicals for the destruction of flowers in an attempt to prevent or reduce fruit set, since young fruit when attacked act as a reservoir of *Phytophthora* spores which pass on to the foliage causing leaf fall.

(c) White Root Disease: Favourable reports were received from several estates regarding the use of "Tillex" for the control of the white root disease of rubber, caused by *Fomes lignosus*.

Adhesion of Dusts: The sticking power of commercial copper dusts on the leaves has been investigated in laboratory experiments by treating dusted leaves several times with water under standardized conditions.

The figures are given in the table below:

Treatment	1% CIBA with sticker % Cu remaining on leaf	6% Blendox % Cu remaining on leaf
After dusting	100.0	100.0
" 1st soaking in water	66.7	45.1
" 2nd " "	64.7	33.5
" 3rd " "	63.7	29.7
" 4th " "	63.0	28.3
" 5th " "	62.3	27.9

It is seen that the copper dust with incorporated sticker is more effectively retained on the leaves than the copper dust without sticker.

Contamination by Copper: Copper compounds which have been found to be the most effective and cheapest fungicides in checking Phytophthora act slowly on rubber causing tackiness of the rubber and brittleness of the goods manufactured from it. The upper limit for copper content of rubber has, therefore, been fixed at 8 parts per million by the Rubber Manufacturers' Association of New York. The copper oxide and copper oxychloride used as dusts for the control of Phytophthora leaf fall are insoluble in water and are absorbed on the rubber particles in the latex and on the scrap, so that only a small part is removed during manufacture. It is important, therefore, that no effort be spared to prevent or reduce contamination by suitable action in the field.

The experiments carried out indicate that the risk of contamination above the RMA limit can be considerably reduced by an extensive blending of latex and scrap from dusted and undusted areas. It is also recommended that all cups should be inverted during dusting and that no tapping should be carried out on the day of dusting. Some experiments have been carried out with two types of rainguards in connection with copper contamination, but the results have not yet been fully analysed for reliable conclusions to be drawn.

(The Rubber Research Institute of Ceylon. Annual Report for 1959.)

SOUTH AFRICA

Locust Control: In the Union the brown locust, Locustana pardalina, towards the end of 1958/59 reached its lowest population level for five years since its large-scale collapse in 1954. The small permanent field staff was able to destroy the few incipient swarms in Kenhardt and Griquatown. Extensive reconnaissance tours during the summer months did not reveal any significant concentrations; consequently, there is little likelihood of early outbreaks in 1959/60.

Valuable research was conducted in the laboratory on the microscopic-internal parasites of the brown locust. Three organisms were isolated, namely, a parasitic amoeba, a bacterium and a fungus, any of which can cause a heavy mortality in the laboratory and possibly also under veld conditions. The effect on the populations of this locust in the veld has still to be determined. The bacterial disease is believed to be transmitted by the egg to the unborn progeny of a diseased female locust.

The International Red Locust Control Service in Central Africa has reported a comparative lull as regards outbreaks in its area. A serious threat was effectively averted in the Malagarasi area of Tanganyika by aerial spraying, and only limited control measures were necessary in the other two important areas, namely, Rukwa and Mweru-Wa-Ntipa. Great progress was made in the technique of hopper control by aerial spraying alone.

A disturbing feature in the control of the red locust, Nomadacris septemfasciata, is the fact that it is capable of multiplying rapidly in the areas outside the known and regularly patrolled outbreak areas, but the International Control Service is maintaining a close watch on the tropical migratory locust. Speedy action on the part of the two International Locust Control Services and aerial spraying should, however, be able to prevent the position getting out of hand.

Red-billed Finch (Quelea): Large invasions of swarms occurred mainly along the north-western border of the Transvaal. As a result of early and copious rains in this area, large-scale hatchings took place, with the result that damage was caused to kafficorn, millet and wheat. However, thanks to an intensive control campaign, the damage generally was but slight. Between the middle of January and the beginning of April, 53 breeding colonies on 683 morgen of land were sprayed (with parathion) from the air, and it is estimated that 70 million finches were destroyed in this way. Later in the season a number of breeding and roosting swarms, most of which probably originated outside the Union, were destroyed in the Southern Transvaal and Northern Free State. On the invitation of the Governments of Southern Rhodesia and Nigeria, officers of the Department visited these countries and supplied them with technical advice on the extermination of the finches.

Tsetse Control: Tsetse fly surveys by means of bait cattle and pigs as well as pupal casing surveys concentrated around the edges of Lake St. Lucia have revealed dense concentrations of *Glossina brevipalpis* in isolated localities in dense bush close to the lake shores with evidence of breeding in these areas. These flies are rather thinly dispersed around the remainder of the shore line of the lake where suitable bush thickets occur.

No cases of nagana in the bait cattle have occurred but cases in the pigs were recorded indicating that the fly is infected with *Trypanasoma simiae* only. The fly appears to be static with no tendency to spread. Experiments with fogging apparatus used at ground level are being carried out.

Blowflies: Colonies of flies representing dieldrin-resistant and -susceptible strains are maintained and used to screen insecticides as these become available. Later the insecticides are tested for residual effect and diffusibility into the wool of merino sheep.

Granary Pest Control: A large number of modern grain elevators were erected and more are in the course of erection. In planning these elevators, a great deal of thought is given to effective insect control which will contribute largely to the control of insect pests. It would appear that control at storage centres is being applied successfully. There are, however, other problems cropping up at these centres and at mills. Exporters are constantly experiencing difficulty supplying products which conform to the export regulations.

Maize: In spite of the large hibernating larvae population, no heavy general infestations of the maize stalk borer occurred during the past season, because in discing and removing stalks left on the land, considerable numbers of the larvae were destroyed. In addition, the timely application of insecticides against the first generation of borers during December, when the maize plants were still in the calyx stage, checked infestation to a considerable extent.

Citrus: During the year a new citrus pest - the citrus black fly, *Aleuracanthus woglumi*, was discovered in and near Durban, and thousands of rough lemon and naartjie trees are already heavily infested. This insect may become a very serious pest should it reach our large commercial orchards where it may cause considerable reduction in yields. A parasite has already been imported from Jamaica in an endeavour to control the pest. Surveys are being made in order to determine exactly its distribution and to obtain a list of other plants which may be attacked. Presumably, as a result of the use of certain generally effective insecticides which also destroy useful parasites, the industry is experiencing increasing trouble from soft brown scale, looper, wax scale, as well as certain mite species, such as the red citrus mite, grey citrus mite and citrus rust mite.

Vermin: The Gerbille, Tatera branstil, caused serious damage to cultivated lands in certain districts of the Eastern Transvaal. Research by officers of the Department has revealed that this pest can be successfully controlled by wheat strychnine bait.

(Department of Agriculture. Annual Report of the Secretary for Agricultural Technical Services for the Period 1st July 1958 to 30th June, 1959.)

Timber Preservation: Experiments to test the effectiveness of chemicals against beetle attacks on hardwood species during seasoning proved after 30 months of exposure and at the end of the incubation season that untreated and dieldrin-treated samples were subject to attacks but that samples treated with DDT and BHC and zinc chloride were not attacked. Only after 28 months did the dieldrin samples show signs of beetle attacks.

Various tests were undertaken in regard to the crystallisation of zinc naphthenate pentachlorphenol on the surface of timber treated with this mixture and a correct method of mixing the ingredients was established.

(Annual Report of the Department of Forestry for the Year ended 31st March, 1958.)

NEWS ITEMS FROM THE COLONIAL TERRITORIES

ANTIGUA

Yellow Fever: Aedes Eradication Campaign: This campaign, which has been conducted in conjunction with the World Health Organisation since 1955 to eradicate the yellow fever mosquito from the island, was sustained energetically during the period under review with financial assistance from Colonial Development and Welfare funds. The *Aedes* index (i.e. the percentage of all dwellings in which the mosquito was found) was over 30% at the beginning of the campaign, but by the end of 1958 it was, for the first time, down to zero. It is expected that the campaign will end in 1959.

(Report for the Years 1957 and 1958.)

BASUTOLAND

Maize: The maize stalkborer caterpillar causes severe damage to maize and sorghum crops every year in Basutoland. An experiment was carried out on farm lands to ascertain the effectiveness of different insecticides and methods of applications. Dusts were not included in the experiment as it is already established that liquid application is preferable to dusting. Granular forms of insecticides could not be obtained in time so could not be included. Aerial applications were by courtesy of Messrs. Basutair, Maseru, using a Piper aircraft delivering 5.5 gal liquid per acre. Insecticides were applied at a cost rate, using endrin emulsion at $\frac{1}{2}$ pint per acre.

It is apparent from the results tabulated below that application was more effective from the ground than from the air.

Treatment	Infestation (% live stalkborer)		
	Before treatment	After 3 days	After 26 days
Endrin emulsion Ground application	82	18	0
DDT emulsion Ground application	83	2	4
Endrin emulsion Aerial application	81	6	18
Systox Aerial application	79	28	24
DDT emulsion Aerial application	84	23	36

(Department of Agriculture, Annual Report 1959.)

BRITISH GUIANA

Rice: Widespread reports of damage caused by the rice water weevil, Lissorhoptrus simplex, were received from many of the rice areas. The attacks were observed to be more severe on broadcast paddy sown late, and approximately 10,000 acres of rice suffered. The normal measure of control recommended was that of draining the land and allowing the field to dry out for a few days before adding fresh irrigation water. However, because of the shortage of irrigation water due to the abnormal dry weather in 1959 this method of control could not be generally adopted.

During the year investigations were carried out on the effectiveness of aldrin and dieldrin when applied as seed treatment on the control of the rice water weevil. It was also necessary at the same time to investigate the effect of the various treatments on the viability of the seed kept for varying periods in storage. There was a slight decrease in the percentage of germination of seed treated with BHC at the rate of 8 oz of 25% WP per 100 lb seed, otherwise all treatments resulted in an increase in the percentage of germination.

The paddy bug, Solubea poecila, also caused some damage, but the pest was kept in control by dusting with 'Agrocide 7' (2.6% gamma BHC) using Motoblos and rotary dusters.

Severe outbreaks of the rice caterpillar, Laphygma frugiperda, occurred on the East and West Coast of Demerara, East Bank, Berbice and on the Essequibo Coast. Generally the caterpillars attack young rice in the nursery and in the field, but in 1959 the attack was observed on reasonably matured plants. In some cases, the crop was completely destroyed and had to be resown. Dusting with 'Agrocide 3' (0.65% gamma BHC) was not very effective against the pest. However, the application of dieldrin and chlordane as a spray gave effective control.

Approximately 1,500 acres of rice on the banks of the Demerara, Berbice and Essequibo rivers were attacked by Blast, Piricularia oryzae, but the loss of grain caused by the disease was not as serious as in 1958. The disease was controlled by two and three applications of an organo-mercuric fungicide, at the rate of two pounds in 20 gallons applied with a mist blower at 8-10 gallons per acre. At the Mara Land Settlement, on the right bank of Berbice river, where the attack of the disease was most serious, about 900 acres of farmers' rice were sprayed with 'Verdasan' at Government expense. The farmers were satisfied with the yields obtained by the treatment.

Widespread outbreaks of brown spot disease, Helminthosporium oryzae, were observed in various parts of the rice areas. The disease was particularly serious in the Mahaicony creek. The control measures recommended for the disease were:

(a) seed treatment with organic mercury compound;

(b) burning of the straw and stubble after harvesting.

and (c) spraying with 'Verdasan'.

Sclerotium disease, Sclerotium oryzae, also occurred in some areas, but it did not cause any serious damage.

Seed paddy was treated with various dressings which included 'Agrosan SW', 'Agrosan GN', 'Ceresan', 'Dieldrex C' and 'Mergamma S'. 'Agrosan' gave satisfactory results and the investigations will be continued in 1960.

Coconut: The most serious insect pests were the large moth borer, Castnia daedalus, and coconut caterpillar, Brassolis sophorae, respectively. Farmers were advised to improve sanitation on their estates, and spray with 1% dieldrin as control measures. Bronze leaf wilt, the result of poor drainage and irrigation, continued to be a symptom of neglect on many properties.

Sugar Cane: The climatic conditions to which the 1959 crop was subjected, fostered an unprecedented invasion of rats into the cane cultivation and provided exceptionally favourable conditions for localised build-up of insect pests, particularly of aphids, mites, mealy bugs, giant borer and army-worm caterpillars. The natural food supplies of the rat inhabiting the savannah hinterlands died off in the drought, large areas of savannah were burnt and rat invasion of the cane cultivation on some estates was such that the normal baiting of a sanitary cordon on dam beds and the perimeter of the vulnerable areas was completely inadequate. Moreover, re-infestation of treated areas occurred with disturbing frequency, particularly following the harvesting of adjacent rice lands and as a result of change of habits by the rat in response to the drought conditions e.g. in-field nesting in fissures caused by soil contraction in place of the usual dam-bed nesting sites.

In addition to greatly increased anticoagulant baiting, thallium and strychnine torpedoes were made in enormous numbers. The services of the Colonial Office rodentologist, Mr. G. I. Twigg, were secured for a period of four months in order to advise on investigations on the biology of the chief rat species, Holochilus, on immediate control measures and on long term preventive measures. The rat infestation was brought under control with pellets of endrin and zinc phosphide. Over ten million pellets were distributed in the fields in a few weeks, by hand in young cane, and by catapult in tall cane. Excellent results were obtained by this method of control.

Citrus: Brown rot disease, Phytophthora sp., occurred on one citrus estate on the West Bank, Demerara. Spraying with 'Perenox' at the rate of 5 lb in 100 gallons applied with a "Motoblo" and completely wetting the tree gave effective control of this disease.

The citrus black bee, Melipona guianea, caused considerable damage to maturing fruits in many citrus orchards in Demerara, Pomeroon, North West District and East Bank, Berbice. Repeated sprayings of a bait of malathion and sugar were necessary to control this pest. Heavy infestations of scale insects, Chionaspia citri, Orthezia insignis, Aonidiella aurantii, Palococcus beckii, Lepidosaphes beckii, were observed especially on trees where the agronomic conditions for the crop were not satisfactory. Infestations of the citrus aphids, Toxoptera sp. were controlled with nicotine and malathion sprays.

Coffee: Sclerotium disease, Sclerotium coffeicolum, caused considerable damage to coffee in the Pomeroon and North West District, and it was particularly severe on young trees resulting in loss of nearly 50% of the crop. Spraying with copper and mercury fungicides was not very effective in controlling the disease. It has been indicated however, that trees which received applications of lime, nitrogen and phosphate showed considerable resistance to the disease.

A number of mature and bearing coffee trees died from attacks by the termite, Nasutitermes sp. Spraying around the trees with aldrin, chlordane and dieldrin was recommended. The leaf-nesting ants, Azecta sp. were a nuisance, but effective control was obtained by spraying with chlordane and dieldrin.

(Annual Report of the Director of Agriculture for the Year 1959.)

BRITISH SOLOMON ISLANDS

Coconut

Nutfall Studies: In accordance with established policy the principal work has been concerned with the study of the Coreid bug Amblypelta cocophaga China, which is the primary cause of nutfall.

Methods of control attempted have followed the two main lines viz:

modification of the ant population of the palms in favour of the beneficial species,

direct control of Amblypelta with insecticides.

Ant Control: It has been established that the ant, *Pheidole megacephala* F, gives no protection against *Amblypelta* and is antagonistic to the beneficial ant species. Trunk spraying with such a powerful insecticide as 1.5% dieldrin has failed to check the advance of *Pheidole* on the Levers Pacific Plantations Pty. Ltd. plantation at Lunga. This failure appears to be due to the strong ground-nesting colonies between the palms remaining unaffected. As expansion seems to be entirely by the general pushing out of ground-nests, further attempts have been made to spray strips of cleared ground. The results of this treatment have not yet been fully assessed.

Beneficial Ants: It has frequently been noted that the two ants which reduce the nutfall damage are associated with certain plants. Trials have been initiated using citrus to encourage *Oecophylla smaragdina* F and *Calapogonium muconoides* to encourage *Anoplolepis longipes* Jerd.

Use of Insecticides: Biological and chemical investigations have been carried out into the residual action of emulsion and crystalline paste preparations of DDT on coconut tissue against *Amblypelta*. The chemical work is being carried out in co-operation with Long Ashton Research Station. Results have shown a rapid loss of residual action with both types of preparation. Absorption of the emulsion by the surface tissues of young nuts and coconut leaves is evident, and the results of similar confirmatory chemical tests on the crystalline paste are awaited.

Laboratory tests have been continued to determine the minimum lethal dosages of DDT both by contact and residual action, for mist spray formulation. Although low rates of DDT are effective by contact, residual action appears to be poor probably due to absorption, as with the emulsion. Dieldrin has been found to be lethal at lower contact concentration than DDT but no residual tests have been carried out. Dieldrin is not favoured as a field spray due to its high toxicity for the beneficial ant, *Anoplolepis longipes*. Results obtained from East Africa on a very similar insect pest control problem of coconuts, indicate that present day techniques are not an economic proposition. This argument may not apply to plantations of dwarf palms. The entomologist's Progress Report No. 6, "Further Insecticide Experiments with *Amblypelta* and Ants", produced in June 1958, gives further details.

(Department of Agriculture, Annual Report for the Year 1958.)

DOMINICA

Malaria: The real position of malaria is hard to evaluate owing to the temporary disorganisation of the Laboratory Service in Dominica as a result of lack of trained staff. An anti-malarial campaign sponsored by W.H.O. and UNICEF is now under way and the preliminary evaluation and reconnaissance of the whole island has been completed. This has shown that the incidence of malaria is almost entirely confined to the Portsmouth Medical District.

(Report for the Years 1957 and 1958.)

EAST AFRICA

Forestry: Termite Control: Control measures fall into two categories - (i) destruction of the termites and (ii) protection of the trees by repellent barriers. Direct attack is at present impracticable against many small underground nesting species, though baiting will be attempted. Various techniques of poisoning mound-building kinds are to be tried. Protection of young trees by mixing insecticides in the planting holes is an orthodox approach, but has the disadvantage of requiring careful application; and the effect is limited to the life of the insecticide, and to its bounds of distribution. In co-operation with the Kenya Forest Department, a trial has been laid down on Uuni Hill, near Machakos. This hill has a history of termite attack, and climatic conditions for trees are difficult. Five hundred *Eucalyptus paniculata* were planted in December, using five different treatments. These were: aldrin 2½% dust, dieldrin 2% granules and aldrin 40% wettable powder in water, with both dry and wet controls. Termite attack has begun, but at this stage no comment is advisable.

Borer: *Oemida gahani*: The infestation of plantations by *Oemida gahani* presents an acute problem. For several years past the Kenya Forest Entomologist has been engaged on the development of palliative control measures, such as the chemical protection of pruning scars and wounds. It has been possible to do little, however, on the basic biology of the pest, population fluctuations, the detection of the borer, evaluation of depredation, or the physiology of the insect. By mutual agreement of the Kenya and E.A.A.F.R.O. forest entomologists these virtually untouched aspects of the problem are to form the main lines of investigation of this Division.

(East African Agriculture and Forestry Research Organization. Record of Research for the Period 1st January to 31st December, 1959. Annual Report 1959.)

FIJI

Forest Pest Control: Toads: Toads now feature as a major cause of damage in nurseries, particularly if sited anywhere near streams or damp areas. Cut-worm or other causes have been blamed for "collapsed" seedlings but it has been shown that the damage has been caused by toads jumping through the nurseries at night. Some 3,000 out of 10,000 Pinus caribaea seedlings were smashed as a result of an invasion in the Research Nursery at Colo-i-Suva. Similar but less heavy damage was reported from Drasa. Netting and poisoning are counter-measures adopted.

(Department of Forestry, Annual Report for the Year 1959.)

JAMAICA

Citrus Fiddler Beetle: In control trials to compare the effectiveness of various soil insecticides in the control of fiddler beetle damage on citrus roots, best results so far have been obtained with 'Dieldrex 15', a single application of which appears to be still exercising control 4 years after the citrus hills were treated.

Citrus Fruit-Piercing Moth: The causes and possible control measures of a malady of mature oranges which produces a number of round, bruised areas on the outer rind, each with one or more minute punctures which go right through into the pulp of the fruit have been considered. All indications are that the damage is caused by fruit-piercing moths, a number of which have been caught by lamplight in the act of piercing the fruit. So far no satisfactory measures have been devised.

Citrus Brown-Stem: Investigations were undertaken to determine the causes and possible control measures of a post-harvest condition of oranges which results in collapse of an area of the peel in the region of the stem-end. Indications are that the condition is related to climatic factors and to the moisture condition of the tree and the fruit at the time of harvest, and that it is aggravated by certain packing-house practices and by any delay which takes place in passing the fruit from the field to the packing-house.

Coconut 'Unknown' Disease: A search for a possible insect or nematode vector of this disease was carried out during the year. A number of interesting species was collected but no likely vector was found. Trials with applications of fertilizers and soil fumigants and the use of certain antibiotics have also failed to offer any lead towards a possible method of controlling the disease. Lethal yellowing therefore remains a baffling problem and practical control is still confined to the felling and burning of all diseased trees which appear on the periphery of the diseased area.

Late Blight of Tomatoes and Irish Potatoes: Trials were continued to compare the effectiveness of various fungicidal sprays and methods of application in the control of this disease. An interesting side-issue of these trials was the occurrence of a noticeably higher incidence of Fusarium wilt of tomatoes in the plots which were treated with one of these spray materials.

Pimento Rust: The advent of low-volume mist sprayers, which are light and easy to move about, and the more effective fungicidal sprays which are now on the market revived interest in the possibility of controlling pimento rust, Puccinia psidii, by spraying. Trials in this direction which were carried out on nursery seedlings during the year have given encouraging results. It is proposed to extend this work to field scale trials.

Nematode Survey: The discovery during 1957 of widespread damage to Lacatan banana fields by the nematode Radopholus similis and the subsequent identification of other types of nematodes on root material taken from several of our commercial citrus orchards, has led to the fear that nematodes may be causing more damage to the island's major commercial crops than is apparent on the surface. Through the good offices of the local I.C.A. mission the services of an expert was obtained during the year to carry out investigations in this field.

Forestry Research. Damping-off Fungi: Adequate control has been obtained of "damping off" fungi affecting pine seedlings by the use of ferrous sulphate, sulphuric acid, aluminium sulphate and formaldehyde.

(Annual Report of the Ministry of Agriculture and Lands for the Year ended 31st December, 1958.)

KENYA

Coffee Pest Control: The pattern of leaf miner (Leucoptera meyricki Ghes. and L. caffeina Washb.) was the same as in previous years. Outbreaks became widespread and severe after the end of the Long Rains but had generally declined by mid-December, except in Upper Kiambu. Following the discovery that the common organo-phosphorus insecticides are ovicidal, revised recommendations were made for leaf miner control. Parathion, methyl parathion and diazinon were the chemicals most used by planters. Experiments at the laboratories of the Pyrethrum Board of Kenya showed that pyrethrum sprays are ovicidal at concentrations as low as 0.001% pyrethrins. A regular supply of mined leaves was arranged from three stations west of the Rift Valley and six stations east of the Rift Valley, including the Taita Hills. Eighteen species of parasitic Hymenoptera have been recovered from these samples. The commonest parasite has proved to be an undescribed species of Cirrospilus. One parasite species is common in Kisii but has not been found in any of a large number of East Rift samples. A number of parasite species recorded in Tanganyika has yet to be found. One surprising observation that emerged from this leaf miner parasite survey is that the shade-loving L, caffeina is absent, or very rare in the West Rift, despite the fact that much of the coffee is shaded. Feeding observations have shown that if L, meyricki moths are given mealybug honeydew their egg production is approximately double the rate of those fed on honey. It must be presumed that aphid, scale or mealybug honeydew is the natural food of leaf miner moths.

Antestia, Antestiopsis lineaticollis Stal., attacks were not outstandingly severe during 1959. This appeared to be due partly to extensive spraying against leaf miner and partly to a high percentage of parasitism of Antestia nymphs by the Braconid Aridelus coffeae Brues. Malathion and methyl parathion were the chemicals most commonly used for controlling Antestia. A two-phase method of Antestia control was devised for African areas and small plantations. Trees are sprayed with 0.006% pyrethrins and their stumps are dusted with 5% DDT. The spray gives a high initial knockdown and the dust ensures that those bugs which recover from their initial paralysis are killed when attempting to climb back on the tree. This work, which was done in collaboration with the Pyrethrum Board of Kenya, is being written up for publication. A *Tachinid* parasite, probably *Bogosia miner* Vill., was bred from adult *Antestiopsis* collected in the Kisii Highlands. Adults kept in cages oviposited freely on the Ruiru variety of *A. lineaticollis* and a new generation of adult flies had bred through by the end of the year.

Using flower buds and small green berries as food a successful technique for the laboratory rearing of the tip borer, *Eucosma nereidopa* Mery. was developed. The larva changed its position two or three times during its development; this corresponds with field observations on its habits. At laboratory temperatures the following approximate development periods were recorded: egg, eight days; larva, 36 days; pupa, 21 days; pre-oviposition, 5 days. Although these stages constitute a total of 70 days, moth counts at Upper Kiambu suggest that the corresponding period in the field is nearly 120 days. It was shown that moth populations could be much reduced by spraying the trunks of shade trees with 2% DDT. It is not yet clear whether this spray complemented with cultural measures will give sufficient control or whether there will have to be other sprays.

It was reported from Tanganyika that the dieldrin treatment for white borer, *Anthores leuconotus* Pasc. control is effective for more than two years if correctly applied. The third phase of the spray campaign planned for April 1959 in the Makuyu district was accordingly cancelled. Surveys took place in April and October to ascertain the effect of the first two sprays. In April only 8 out of 2,500 trees on 10 estates were still harbouring active larvae; in October no active larvae were found in 2,500 trees. Coffee which was too young to be treated during the 1958 campaigns was badly attacked and had to be treated.

There was a severe, but fortunately fairly localised, outbreak of the yellow headed borer, *Dirphya nigrecornis* Ol, in the Thika district. Several new observations on the life history of this pest were made. 0.2% dieldrin in kerosene, injected into the tunnels, proved a useful substitute for the fumigant EDCT and was widely used as a control measure.

Lace bug, *Habrochila ghesquierei* Schout. extended its range to the Nyeri and Embu districts during the year. Though there was a number of severe outbreaks in Kiambu, Thika and Ruiru, on the whole it caused less trouble than in previous years.

During the year small-scale investigations were also undertaken on the control of coffee thrips, Diarthrothrips coffeae Williams, waxy scale, Ceroplastes brevicauda Hall, brown scale, Saissetia coffeae Walk., and other minor pests.

(Annual Report and Accounts of the Coffee Board of Kenya for the Year ended 31st March, 1960. Kenya Coffee, May 1960, 25, (293), 167-184.)

Coffee Pests: Spraying shade tree trunks with 2% DDT caused large reductions in the moth population, but it is not yet clear if this alone is an adequate measure. Leaf miner eggs are killed by parathion, methyl parathion and diazinon at the concentrations used for killing the caterpillars in the mines.

In the search for suitable fungicides, trials have emphasized that copper formulations, when correctly timed, give more consistent control of coffee berry disease than captan.

Cotton Pests: These caused less damage than usual but the bollworm Heliothis armigera caused considerable damage especially towards the end of the season. Full control of pests on the Msabaha Cotton Research Station resulted in a crop value increase of 75% as compared with 114% in 1958 and 294% in 1957. Excellent results were achieved against cotton pests by aerial spraying on the Tana River Irrigation Scheme but a sudden late attack of Heliothis bollworm occurred after the completion of the main spraying operations. Cotton pests in Nyanza suffered from a severe drought in June and July and numbers of stainers and bollworms were low in the Lake Shore area. 3% gamma BHC/10% DDT dust increased yield by some 30% and was superior to endrin/malathion/DDT dust mixture at Kibos.

Miscellaneous: Dieldrin spraying against banana weevil gave smaller yield increases than did mulching. In the Rift Valley Province seed dressings of dieldrin, heptachlor, or aldrin against barley fly gave superior control to all, others. Dieldrin seed dressing at $3\frac{1}{2}$ oz of actual dieldrin per 100 lb of seed was as effective as the recommended dose of 5 oz. Severe attacks of the chafer grub, Schizonycha spp. occurred in maize and wheat in the Trans Nzoia and spraying with dieldrin and chlordane did not give satisfactory control. Seed dressings of dieldrin, aldrin and heptachlor showed promise in shallow trays. Good control of pyrethrum thrips outbreaks has been achieved by spraying DDT twice at an interval of 10 days. Metasystox gave good control of both thrips and red spider mite. Work on Nematocerus weevils is being assured a high priority because of serious damage to wheat. A second large maize stack experiment, using polyethylene covers to give long-term protection, was completed and gave results which justify further large-scale trials. A stack experiment involving layer dusting of maize with 1% lindane gave conclusive proof that the technique was not economic. Results from a crib experiment showed that when sprayed hessian sheet was used within the wire the addition of resin had no significant effect.

Biological Control: Eretmocerus serius, a parasite of the black fly of citrus, Aleurocanthus woglumi, a serious pest of coastal citrus was introduced in November from the Seychelles, and the parasite appears to have established itself. The Cochineal insect, Dactylopius tomentosus, continued to multiply and showed great promise more particularly on the type of prickly pear with thin bracts which occurs at Mariakani and Mohoru. Against types with thick bracts it is less effective but good progress is reported from Naivasha. The Lantana seed fly, Ophiomya lantanae has now spread throughout the Colony. The lacebug Teleonemia scrupulosa liberated in Nyanza appears to have died out but is now causing appreciable damage to Lantana at the Coast. A leaf skeletonizer, Syngamia haemorrhoidalis was introduced from Hawaii to attack Lantana but it is not yet known to be established.

Quelea Control: This year may prove to have been the turning point in the success of efforts to solve the Quelea problem. Until 1959 it was doubtful if control measures within East Africa were keeping pace with the ever increasing population development. Increased knowledge of the Quelea breeding grounds and the development of better and more economic aerial spraying techniques give hope that with additional finance available in Tanganyika, numbers may be so reduced over the next few years that the species will no longer constitute a major threat to small grain growers in large areas of East Africa. Should this prove correct routine control at source would be sufficient to prevent future outbreaks.

A campaign was undertaken in the main Tanganyika breeding grounds where 1,525 acres of breeding colonies were dealt with in 15 operations. A total of 91,572,000 Quelea were destroyed. Of this total 38,600,000 adults and 34,250,000 young were accounted for by the new aerial spraying technique using 516 gallons of parathion over 1,050 acres. A very large roost was found near the Mwea-Tebere irrigation scheme in January which if left would have resulted in the destruction of the entire crop. It was at this roost that the new curtain-spraying method was evolved. At this roost and another at Olelondo just under 3,000,000 Quelea were accounted for. Comparatively few birds entered the Rift Valley wheat areas later in the year and although 15 blow-ups were undertaken only an estimated 350,000 birds were destroyed.

(Department of Agriculture, Annual Report 1959, Vol.I.)

Capsulated Concentrate: A special pyrethrum concentrate is now available in gelatine capsules (similar to those used for lighter fuel). This concentrate is miscible with both kerosene and water. Tests at the Coffee Research Station have shown that if the contents of one capsule are mixed with a pint of kerosene the mixture is fully equal to the "double strength" extract recommended for Antestia testing. Planters are advised to buy these capsules rather than ground flowers. The advantages are that the extract is cheaper and much easier to prepare and there is no variation in pyrethrum content from batch to batch. The capsules are available through all the usual suppliers.

(Kenya Coffee, May 1960, 25, (293), 165.)

MAURITIUS

Forest Pest Control: Gonipterus scutellatus Gyl. continues to be kept under control by its egg parasite Anaphoides nitens, and no damage of significance was reported during the year in eucalyptus plantations. Cratopus punctus continued to cause some damage to young 'camphor', (Cinnamomum camphora). Hypsipyla robusta, the cedar or mahogany shoot borer, causes damage in young mahogany plantations but though the young trees tend to fork low and branch excessively they appear to be able to achieve a fair form under regular pruning and at from five to seven years of age look promising.

Monkeys are the principal pest in the upland pine plantations, particularly where undergrowth is dense. At certain seasons they are very partial to the tender bark of leading shoots which they strip systematically to leave them naked. A minor measure of control is achieved by shooting but no real measure of success has been achieved. Deer do some damage to pine trees by stripping bark up to heights varying from two to five feet from the ground, occasionally ring barking trees completely. There has been a marked reduction in the last two-three years in the amount of deer damage.

In certain parts of the Island tree rats feed heavily on immature pine cones and the fruits of Casuarina equisetifolia. The extent to which large immature pine cones are gnawed to the core is in some cases astonishing, almost every cone on some trees being eaten.

(Annual Report of the Forest Department for the Year 1958).

MONTSERRAT

Yellow Fever: A campaign to eradicate the Aedes aegypti mosquito began in October 1957. The World Health Organisation provided an advisory consultant together with the materials and equipment. By the end of 1958 the whole of the island had been covered and only one locality (in the town of Plymouth) was positive. The campaign was to continue through 1959.

(Report for the Years 1957 and 1958).

NORTHERN RHODESIA

Tsetse Control: The picture of tsetse fly during the year was one of activity and a growing tendency to encroachment. In general, the initiative against the fly has been held, and by selective bush clearing, game exclusion, insecticidal fogging and spraying, and planned settlement the advance has been halted and turned back. In view of the enormously long fly front, major operations have had to be confined to areas where the threat of fly infestation posed immediate economic problems, as only by concentration of effort can results be achieved. Other areas are, however, not entirely neglected; a careful watch is kept, and limited holding operations were undertaken. There is now no province which does not have its fly problem. In Barotseland, which was hitherto virtually free, an extension of fly northward along the Mashi River is a serious threat to the cattle industry, and recruitment of extra staff to meet it is now in hand. As the parent fly belt of this extension lies in Angola and the Caprivi Strip, international co-operation is desirable, and is being sought.

Glossina morsitans is the common tsetse fly of Northern Rhodesia, but G.pallidipes is becoming increasingly apparent. There is a small focus of G,palpalis at the southern end of Lake Tanganika. During the year, 110 cases of human trypanosomiasis were recorded.

Summary of activities:

Bush clearing and insecticidal fogging have been successful on the East Lusaka front; fly density has again been halved, and there were no fresh outbreaks of trypanosomiasis after July.

On the Mumbwa side, clearing has been in progress on the edge of the Kafue Flats, and resettlement schemes are going according to plan. Surveys have been made in North Mumbwa and pickets posted to control further dissemination.

On the Kafue Flats, fencing and discriminative clearing have been further extended, and numerous surveys undertaken.

The Kalomo game fence has served to reduce fly density very greatly, and plans have been laid to extend the fence northward.

In the Machili area, bush clearing was continued, and control of movement instituted, to protect the cattle of Sesheke District.

In the Kariba resettlement area, much bush clearing and insecticidal spraying have been done, and one small area is believed to have been completely cleared. The terrain is extremely difficult.

The Chingola fly pocket was reduced almost to eradication point. In Kasempa, the incidence of sleeping sickness has risen.

In Kawambwa, discriminative clearing failed to halt an encroachment, and game exclusion is being undertaken.

In the Northern Province, good results were attained at Abercorn, especially against G. palpalis on the lake shore, where spraying with dieldrin has proved effective. Some spontaneous regression of fly was noted in the Mpika District.

In the Eastern Province, active measures were concentrated in the Fort Jameson District. The object is reduction of fly density within a perimeter to a level tolerable to man and his livestock, with the aid of chemoprophylaxis, after which increasing agricultural activity will complete the process of eradication.

In Barotseland, threats are developing at four points, the most important being that from the extending Angola fly belt. Pickets have been established, to stop carried fly, and the cattle at immediate risk have been put under drug prophylaxis.

Tick Control: Anaplasmosis, Rickettsiosis and Babesiosis are ever-present, and any relaxation or inefficiency in tick control is at once followed by outbreaks. The newly introduced organo-phosphorus dip washes have giovn excellent control of all tick species. There have been no reports of poisoning, despite their high toxicity.

Studies were continued on the effects of microclimate on Rhipicephalus evertsi. Previous observations on the effects of submersion, temperature and humidity on survival, ovipositing and subsequent eclosion were confirmed and extended. It is clear that high temperature and low humidity are more important factors in limiting tick proliferation on the Kafue Flats than the annual flooding. The long grass (*Hyparrhenia*) areas provided the most suitable environment. The engorged females in these observations were enclosed in cotton mosquito netting bags, to facilitate recovery. It was noted that over half disappeared, and in many cases torn and stained bags were found at up to fifteen inches from their original location. Rodents are plentiful in the long grass areas, and it is possible that they were the responsible predators.

(Ministry of Land and Natural Resources. Department of Veterinary and Tsetse Control Services, Annual Report for the Year 1959.)

NYASALAND

Forest Pest Control

Insects: During the year some improvements in the control of termite damage were brought about by the use of better nursery stock, by improved planting, technique, and by the application of aldrin at the time of planting. Although this indicates that some measure of success can be obtained, it cannot yet be claimed that the termite problem has been overcome.

In an attempt to control the small white aphis known as "Jacaranda Blight", a consignment of the ladybird, *Hyperaspis jocosa*, was obtained from the Scott Laboratories in Nairobi, and the insects were liberated in two places in Limbe. It is believed that it may be necessary to repeat this introduction. Disfiguration of the jacarandas near the Headquarters office in Limbe is noticeably less since the spraying of the trees with 'Alboleum' in 1958.

Material of ornamental hibiscus infested with the hibiscus borer, *Pseudagrilus dubius*, was sent to the Department of Agriculture, Pietermaritzburg, Natal, which is undertaking research into methods of control of this pest.

Rodents: At Chikangawa and Zomba Mountain Forests, damage by rats was again successfully controlled by the use of "Sorexa" rodenticide Poison baiting was carried out over 742 acres at Chikangawa, and it is believed that the problem of rat-damage in short grass areas can now be considerably minimized, if not entirely overcome.

(Annual Report of the Department of Forestry for the Year ended 31st December 1959.)

SWAZILAND

Veterinary: Cattle Disease Control: There is controlled dipping of all cattle in the Territory to combat tick-borne disease and regular inspection of all livestock by departmental officials for disease control. The stock disease position was more favourable and the outbreak of East Coast Fever was brought under control. Cattle sales could accordingly again be begun during May in part of the Territory. A universal sheep and goat dipping campaign as a control measure against sheep scab and goat mange was successfully conducted during the year.

Public Health.

Malaria: The malaria position remains satisfactory. Control measures have now been discontinued over a further area and are now confined to irrigation schemes and large farming estates at which there is a considerable "turn-over" of migrant labour, the area covered being approximately 1,300 square miles in extent. In the remaining previously malarious areas active surveillance measures are carried out consisting of taking blood slides from children and from all cases of febrile illness encountered, administration of anti-malaria drugs to all immigrants from uncontrolled neighbouring territories, and the collection of entomological specimens. An attempt is made to trace and treat every case giving a positive blood slide. During the year 7,188 blood slides have been examined, of which 45 were positive for malaria parasites. Of these positive cases, 33 were immigrants. In the pre-control era, between 4,000 and 7,000 cases of malaria were reported annually and there were thousands of unreported cases.

Regular test-spraying of African huts, has also been carried out. In 2,926 huts sprayed, only one Anopheles gambiae and ten A. funestus were discovered. The World Health Organisation Anopheles gambiae Advisory Team worked in Swaziland from 12th February 1958 to 29th April 1958. Confirmation was obtained both of the scarcity of vector mosquitoes in African huts, even in areas where no spraying has taken place for three years, and of the altered feeding habits of A. gambiae, which is living almost entirely on animals.

Bilharzia: No large scale bilharzia control measures have yet been instituted. A considerable amount of investigational work was carried out in 1958, both on the incidence of the disease in the local population and on snail vector problems.

(Report for the Year 1958.)

TANGANYIKA

Malaria: Malaria control methods continued to be drainage and larviciding in settlements using Malariol high spread or BHC powder, depending on the nature of the anopheline breeding site. In two areas of the territory large-scale residual spraying of houses was undertaken. At Mpanda, the Malaria Division carried out another spraying cycle. The settlement, a heavily populated island of hyperendemicity, surrounded by uninhabited tsetse bush was considered a suitable place for this type of malaria control, particularly as larviciding had only been partially successful on account of the large number of overgrown dams situated in the centre of the settlement. The results obtained from residual spraying were more effective than were the previous attempts at larval control and it was considered that in the special circumstances of Mpanda this method of malaria control was the one of choice.

In last year's report reference was made to the attempt to control malaria by residual spraying at Mtwara. One cycle of spraying was carried out in the first quarter of 1949, but for reasons which were difficult to assess the population did not favour the spraying of their houses and the anti-malaria personnel experienced considerable difficulties. In view of this resistance it was decided to revert to mosquito control by drainage and larviciding. This was a continuation of earlier trials on mosquito larvicides safe to fish. The series included chlorthion floating dust, and chlorthion, 'Baytex' and methyl parathion granules. This work was carried out at Malya in the Lake Province.

At Amani, trials were arranged with gelatin capsules containing high spreading oil formulations of BHC for the control of anophelines and culicines in relatively inaccessible breeding places.

Bilharzia: In the conditions obtaining in this territory so far no practical method of control has been devised and thus it has not been possible to make any rational attack on this problem. Attempts have been made, in special circumstances, for example on a sugar estate at Arusha Chini in the Moshi District, to control the infection by the application of molluscicides to irrigation channels, but this achieved only limited success. In the many water conservation projects, particularly in Sukumaland and Unyamwezi, no practical means of controlling snail infestations has been devised and the many dams that have been constructed, beneficial though they are to the people and the cattle in one respect, continue to represent a real danger from bilharzia and malaria. As settlement of new areas occurs there is evidence of the spread of bilharzia to them and it thus is a matter of urgency that an effective system of control be devised.

(Report on Health Services, 1959.)

Accidental Poisoning of Cattle: Cases of suspected poisoning were recorded in all Provinces and in the majority of cases the causal agent was identified. Hydrocyanic poisoning was confirmed in a number of cases resulting from the ingestion of wilted Star Grass (Cynodon spp.) and at Tanga Dairy ingestion of wilted herbage in pastures topped with a rotary mower led to decoumoral poisoning in adult cattle. Cases of Dichapetalum poisoning occurred in coastal provinces and in the Northern Province hydrocyanic poisoning was suspected among cattle grazing maize stover infected with the fungus of "Pink Ear Rot". Poisoning from overstrength dip and spray washes was recorded, both arsenic and "Gammatox" being implicated.

Tick Control on Cattle: Spraying and dipping measures are encouraged by the Department of Veterinary Services to reduce the incidence among cattle of the tick-borne diseases, East Coast Fever, Heartwater, Anaplasmosis and Piroplasmosis.

There has been a welcome revival of interest in the Lake Province with the renewal of dipping activity and even demands for extensions to facilities. Further examples of an awakening to the benefits of dipping and spraying were to be seen in West Lake Province where dipping increased steadily throughout the year. Perhaps this is not surprising when it is realised that calf mortality is estimated at 70% in certain areas. The popular established voluntary dipping practices in the north of the Western Province are showing dividends and the mortality due to the disease is falling. Further dipping tanks were completed (5) or planned (5) during the year. In Kahama District total immersions increased by over 320,000, which is indicative of the popularity of these voluntary schemes. In the Rungwe District of the Southern Highlands Province notable advance has been made through the efforts of the Field Officer. Some 200 crushes were built by stock owners for spraying. Initially pumps were loaned by the Department and demonstrations given free for a three-month period, which was sufficient to show demonstrable improvements in condition. Following these demonstrations owners were encouraged to purchase their own spray pumps and continue spraying at their own expense. The success of this exercise was shown by the purchase of thirty-two pumps and sufficient "Gammatox" to spray 50,000 head of cattle. In addition, the demand is such that a commercial firm now has a resident African selling agent, and sales in the last quarter of the year rose to £200 of equipment and medicaments.

In the Northern Province the recorded losses from the disease were the highest for many years, particularly amongst European herds where supervision at dips inclined to be inefficient. In Mbulu, however, there was a tremendous demand for dips. An ambitious programme of construction was undertaken. It is of interest that several small stock dips were also made and operated. Enthusiasm was such that even donkeys and pigs were dipped. A less encouraging picture was to be seen in most parts of the Southern Highlands Province where, in the endemic areas, 15% mortality was common, frequently aggravated by poor management and nutrition. Two severe outbreaks in marginal areas near Mbeya resulted in a 60% mortality. To date there has been no recrudescence of the disease in Iringa District.

Spraying of cattle with 'Gammatox' and 'Coopertox' was standard procedure on the Departmental Farm at Tanga.

Tsetse Control: Whilst the importance of human sleeping sickness is realized, the problems of trypanosomiasis is greater in animal industry, and the reclamation of land, presently unusable because of the presence of tsetse fly, will solve both problems, thereby providing greater productivity from the land. Thus, on the retirement of Mr. H. M. Lloyd, A.R.C.S. (London) F.R.S.E., for twelve years Director of Tsetse Survey and Reclamation Department, in June, 1959 that Department became part of the Department of Veterinary Services. The Administrative Officer in charge of tsetse work was designated as Chief Tsetse Officer and was to be stationed at Veterinary Headquarters. Unfortunately this post remained unfilled by the end of the year and this officer's duties were assumed by the Chief Veterinary Research Officer.

It was found necessary to continue the thousand-yard fly barrier on the Great North Road, in the Northern Province, through the Kaiti Palm Forest.

Among other items reported: Work continued in the Mbulu District to clear a fly barrier around the whole district. In all, some twenty-nine square miles of fly bush were reclaimed, principally in the Yaida Valley. In the Lioborsiret Reclamation Scheme, selective clearing opened up a grazing area of some 1,200 acres on the Mburet-Endonyo cattle route, this work being completed in April. Preliminary surveys were carried out in the Sonjo country (Loliondo) during August, where it was found that Glossina pallidipes was present over a wide area. In the Pare District of the Tanga Province a survey of the area between the Usambara Mountains and the Pangani River was made to determine the breeding habitat of fly in that area. Generally speaking these were found to be in the foothills and an eradication programme, coupled with proposals for better land use, was prepared for that area.

In the Western Province, where the danger of human sleeping sickness is greatest, the following works were carried out: In the Kahama District clearings were carried out between Msasa and Ushirambo in order to link up the two settlements. On the shores of Lake Tanganyika, north of Kigoma, whilst fly continued to be found and eradication by spraying was carried out, no cases of *Trypanosoma gambiense* Sleeping Sickness were diagnosed. The foci of fly, or centres of re-invasion, are repeatedly sprayed annually. The position in the Kigoma-Luiche-Ilagalla triangle was not so happy and a number of sleeping sickness cases were reported. A survey of the Malagarasi River and Ruchugi River was undertaken during the year and *Glossina palpalis* were found north of Uvinza, which demonstrated the necessity and importance of maintaining permanent anti-tsetse measures in the Lake coastal areas of this Province. It is unfortunate that the barriers cleared in 1951 to protect Kigoma itself have not been settled and it is possible that regrowth has allowed fly to reinhabit the barriers and to breed.

In the Kibondo area clearing was continued in the north-western portion of the district in order to enlarge the settlements and also to link them. This was being carried out by discriminative clearing and at the same time a barrier along the eastern edge of this inhabited area was being created. A small amount of clearing work was also carried out in the Kasulu, Nzega, Mpanda and Tabora Districts during the year. It is of interest to note that at Kabanga the International Locust Control Scheme camp and airstrip on being surveyed were found to be infested with *G.morsitans* and that one spraying of this area resulted in freedom from fly for five months.

In the Central Province no major surveys were undertaken but investigations were made to determine the fly front in relation to village settlement in the Bubu Valley. The clearing of the Kinyasi Ridge continued throughout the year with a permanent labour gang; survey traces and an access road were also cut. Close by, the first series of aerial application of insecticide were applied to a neighbouring, well defined area of tsetse fly, but were not as successful as had been hoped and a fresh series were started in September.

Fly rounds were continued in the Mang'onyi Reclamation area and a satisfactory reduction in fly was noted. Work continued in the Mang'onyi Irrigation Scheme and consisted of discriminative clearing in the blocks of deciduous thicket and up drainage lines. Some 5,200 acres of land have been treated in this area since the inception of the scheme.

The closing of the E.A.T.R.O. Research Laboratory at Old Shinyanga marked the end of thirty years of anti tsetse research work. A further survey of the Mara River Valley has been carried out in collaboration with the Colonial Pesticides Research Unit Arusha with a view to spraying the entire area with insecticides.

(Annual Report of the Department of Veterinary Services 1959.)

TRINIDAD AND TOBAGO

Malaria- Residual Spraying: Despite the known resistance of *Anopheles aquasalis* and *A. bellator* to dieldrin, its substitution for DDT throughout the territory in the residual house spraying programme was instituted at the beginning of 1958. The main reason for this decision was the fact that spraying with this insecticide was the sole weapon available for the eradication of *Aedes aegypti*. The number of cases of malaria was low and the practical effects of dieldrin coupled with bromeliad spraying and drug treatment enabled the Division to maintain a low level of transmission until it was free to devote its full energies to malaria eradication.

Spraying operations were carried out throughout the whole of the two islands and accounted for 98.5% of all houses. UNICEF supplied dieldrin wettable powder, spraying machines and spare parts, and PASB provided some of the protective equipment required.

The programme of work in Tobago included mosquito investigations, larviciding of all water bodies in which *Anopheles* mosquitoes were found, residual spraying of every house in the island, larviciding of all water containers with BHC by two perifocal teams, evaluation with a unit of eight evaluators taking blood smears from every individual on the island, and maintenance of capital works. Heavy overgrowth of bushes was cleared in and around several rivers, swamps and pools.

The dieldrin spraying of houses there, was carried out by a 16-man team which for purposes of covering the entire island was divided into three units. A total of 6,567 houses was sprayed. Perifocal operators were attached to the residual Units for larviciding with BHC and searching for *Aedes aegypti* larvae.

Yellow Fever: Advantage was taken of the plan for the spraying of all premises in the malarious areas of the territory with dieldrin as part of the malaria eradication programme, and provision was made to treat at the same time all places which were not included in the malaria eradication programme so that all houses in the islands would be sprayed. Special effort was taken to achieve 100% coverage by the organisation of units for making contact with occupiers and owners of closed and vacant houses and spraying these houses outside of normal working hours as so often became necessary. A perifocal team worked on the premises along with the residual team searching for foci and treating perifocally all actual and potential breeding places of *Aedes aegypti* using BHC "Gammexame P 520").

Three residual spraying teams of 35 men each were organized to carry out the programme in Trinidad. In addition, a team of men worked for a year in Port-of-Spain. Two teams also worked in Tobago for 6 months and San Fernando for 3 months. It became necessary to increase the original teams in order to complete the programme set for the whole year and the year ended with the original teams being increased to 158 men working at 5 centres instead of the original 3.

In addition to the residual spraying teams, 158 men in 25 teams were engaged in perifocal treatment and checking for *A. aegypti* in Trinidad and 12 men in 2 teams in Tobago. This was a reduction in the number engaged during 1957 and was necessary in order to implement the dieldrin plans. Certain areas therefore, could not be worked until the residual team with their accompanying perifocal team reached them.

Aircraft disinsectisation: During the period under review 7947 aircraft were sprayed. Ninety five per cent of the insects collected were live flies.

(Medical and Sanitary Report of the Department of Medical Services for the Year 1958).

Mosquito: Susceptibility Tests: The following results were obtained on three species tested using WHO test kit:

Species	Locality where collected	DDT	Dieldrin	BHC
Anopheles aquasalis	Baracaria, Trinidad	Susceptible	Resistant	Moderately resistant
	New Lapaille, T'dad.	Susceptible	Resistant	-
	Cedros, Trinidad	Susceptible	Resistant	-
	Fishing Pond, T'dad.	Susceptible	Resistant	-
	Guayaguayare, T'dad.	Susceptible	Resistant	-
Aedes aegypti	Point Fortin, T'dad.	Resistant	Susceptible	Susceptible
	Kingston, Jamaica	Resistant	Susceptible	Susceptible
Culex fatigans	San Juan, Trinidad	Resistant	Resistant	Resistant

The results of tests carried out with *Anopheles aquasalis* at Barataria in 1958 established conclusively that a certain proportion of the population was highly resistant to dieldrin. The mechanism of resistance in *Anopheles aquasalis* is not yet known, but the results point to a mechanism similar to that for *A. gambiae* in Africa. Results at Barataria showed conclusively that selection was taking place while testing was in progress shortly after dieldrin was applied. With resistance being detected so quickly after dieldrin spraying in Trinidad, it appears fairly certain that the factor for resistance, whether it be a gene allele or otherwise, was present in the A. aquasalis population even before residual application of this insecticide. The ability to withstand 8 hours exposure to 4% dieldrin indicates the presence of highly resistant individuals in the population, most likely dieldrin resistant homozygotes. Testing in other parts of Trinidad showed clearly that there was resistance in all four corners of the island. As the island is small, resistance is felt to be widespread over all the A. aquasalis areas of the Colony.

The results of tests carried out with the Trinidad Aedes aegypti are in agreement with earlier findings with larval tests that the species is highly resistant to DDT while still susceptible to BHC and dieldrin. The ability of about 30% of the blooded females of the Jamaican strain to withstand 4% and 8% papers for 8 hours is a clear indication that the species is resistant to this insecticide. It is not known whether this phenomenon is widespread over Jamaica since the eggs from which the colony was started were collected only in the Kingston area. But again it is felt that the factor for DDT-resistance is present in that island and that resistance elsewhere in Jamaica will show up as soon as the susceptibles in the population are wiped out by perifocal operations.

The village of San Juan has had residual applications of DDT for several years as part of the malaria control programme. In 1958 dieldrin was substituted for DDT in the Malaria Eradication Programme. In the village of Matura house searches carried out in July and August 1958, revealed thousands of Culex pipiens fatigans resting on walls which were sprayed with dieldrin at the rate of 60 mg per sq. ft only a few days earlier. The results of tests carried out with this species showed clearly that the species was resistant to both DDT and dieldrin. It is felt that in the case of Culex fatigans resistant individuals were present in the population before dieldrin was initially used. (Resistance to dieldrin in the case of A. aquasalis showed up only a month after first use of this insecticide in houses.) This is the only species tested so far in Trinidad which is resistant to both DDT and dieldrin.

Mosquito Traps: Many of the Shannon Dawn Traps, which in previous years did not make good, are now replaced by similar traps built with Dexion. These traps have also been fitted with an adapter cage in which mosquitoes can be collected directly and used for various purposes without unnecessary handling.

Mosquito: Residual House Spraying: Work was carried out in Trinidad during 1959 by 5 teams comprising 132 men and in Tobago by 1 team of 20 men, each under a Senior Field Inspector. Each team had the use of a truck and a jeep or jitney as required. 149,903 houses were notified for spraying. Of these 80,725 were sprayed with dieldrin, 49,370 with DDT on the first cycle and nearly 20,000 on the second cycle. The number of unsprayed houses reached a record low figure of 505 (0.3%). This was due mainly to the redoubled efforts made by the rechecking units of the residual teams and the work done outside of normal working hours to meet householders at times more convenient to them. There was also a marked reduction of resistance and non-cooperation of householders by the absence of staining of walls during the previous year and the effects of the dieldrin spray on several household pests.

Bromeliad Malaria: The spraying of host plants of Anopheles bellator and other plants with copper sulphate and their manual removal, wherever necessary, was satisfactorily carried out in the Sangre Grande and Matura areas.

Aircraft Disinsectization: A total of 7,878 'planes were inspected and disinsectized during the year 1959. 188 insects were identified. The vast majority of insects found in 'planes were non-pathogens.

(1959 Annual Report of the Malaria Division, Health Department.)

UGANDA

Tsetse Control: The year 1959, like the latter part of 1958, continued to be the most difficult period experienced in the tsetse control field in Uganda since the early 1950's. Unusually favourable conditions for increases in Glossina morsitans population prevailed and, as stated last year, the only explanation that can be given is that the increases have been due to some favourable long-term climatic change. Whatever the reason, the result has been that, in spite of further control activities on a substantial scale in all four of the residual tsetse reclamation zones of northern and central Uganda, no further improvement in the G.morsitans situation was achieved in either the south-west Lango or the north Karamoja areas. Moreover, the year ended without any real certainty that further extension of the G.morsitans fly-belt of north-east Ankole had been successfully halted.

Despite these difficulties, good progress was made in a number of directions, most noticeably in control with insecticides, particularly against the waterside tsetse, G. palpalis. The principal tsetse control task in 1959 continued to be the halting of the further spread of the G. morsitans fly-belt of north-eastern Ankole, which was reported in 1958. In that year, after six years unremitting effort by the East African Trypanosomiasis Research Organisation, the fly-belt had more than quadrupled its 1952 extent of some 250 square miles.

Hunting out of game in the northern and eastern peripheral areas of the belt continued throughout the year and eventually covered a total area of approximately 1,700 square miles. As a subsidiary measure, by mid-year, all cattle had been evacuated from a broad zone in front of the whole length of the advancing fly-front. By late 1959 there were good grounds for believing that a further eastward spread of this fly-belt had been successfully halted. But to the north-east and north the position remained far from certain. It was accordingly decided, in October 1959, to supplement the hunting effort in this region by creating a half-mile wide "insecticidal barrier" along the 50-mile length to the northern fly-front. This work was started in November. The barrier was being formed by spraying residual insecticides (three per cent dieldrin) on all likely resting places of the fly on the vegetation covering the half-mile wide strip.

A further encouraging feature of the year's work in Ankole was the very marked reduction in routine tsetse catches in many parts of the game elimination zone as compared with a year earlier. In north-western Ankole good progress was made with strengthening consolidation against southward re-invasion by G. pallidipes and G. fuscipleuris by means of further undercutting of riverine bush and organised settlement of people in the clearings. In south-east Bunyoro a new line was agreed on for consolidation in the west, and further control by hunting was almost entirely discontinued. In the fully reclaimed 500 square miles area of south-east Bunyoro cattle numbers continued to build up without any incidence of trypanosomiasis.

In the residual 300 square miles Maruzi reclamation area of south-west Lango a further season of hunting was undertaken in January/June 1959. G. pallidipes numbers had dwindled to an extremely low level by the end of the year, but numbers of G. morsitans, though still of a vary low order, did not, unfortunately, show a similar response. In northern Acholi further progress was made with the pushing back, further north along the Aswa Valley, of the southern limit of the G. morsitans salient. This was achieved by bush-clearing along the drainage lines which had earlier been found to harbour the main concentrations of fly in this area.

In the north Karampja consolidation area further bush-clearing was carried out. In spite of this there were substantial increases in tsetse densities in many parts of the clearing zone. Moreover, during the latter part of the year survey findings revealed that it would be necessary to extend the barrier clearing zone considerably further southwards, especially at the western end. An intensified effort was accordingly mounted in December.

Control operations with insecticide continued, almost invariably to be attended by immediate success. The effective control of G.palpalis in the north Lango sleeping sickness area was successfully maintained by bi-monthly spraying of barriers across the likely avenues of re-infestation. The effectiveness of this vector control on the human sleeping sickness situation can be measured from the fact that only seven new cases were reported during the last six months of 1959, as compared with 90 in the corresponding period of 1958.

Following a limited increase in Gambian-type sleeping sickness in West Nile District late in 1958, spraying of the waterside thickets which was started in this area was continued until June 1959. Some 85 miles of watercourse were sprayed with 6% dieldrin and systematic fly searches were maintained until October; but no further captures of G.palpalis were made anywhere in the sprayed zone from the end of June onwards. However, owing to the slow onset of this type of sleeping sickness it was too early to assess the effectiveness of this spraying. The 1959 total of new cases was 27, as compared with 8 in 1958 and 20 in 1957. But, on the analogy of events in north Lango, a perceptible decrease in new cases should occur in 1960.

In Bugerere County of Mengo District, Buganda, a residual focus of G.brevipalpis along the west bank of the River Nile was eradicated successfully by means of a single application of 6% dieldrin.

Virus Disease: There was no serious outbreak of any of the recognised infectious disease during the year but a widespread epidemic occurred of an apparently new disease with unpleasant symptoms closely comparable with those of dengue. About 500,000 people were affected but there were no deaths and those affected were generally incapacitated for five to seven days. The East African Virus Research Institute succeeded in isolating the virus which was a new one, found to be transmitted by two species of Anopheles mosquito.

Malaria: Mosquito control in townships and the widespread use of prophylactics has considerably reduced the risks of malaria. The World Health Organisation anti-malarial project in Kigezi progressed well under the enthusiastic leadership of Dr. de Zulueta. The anti-malarial unit commenced the spraying of huts in May. One hundred per cent co-operation from the local population was obtained. At the end of the year, amongst the population of 40,000 in the areas sprayed in May, no infant under six months old had been found with parasites in the blood.

Onchocerciasis: Investigations continued into the bionomics of Simulium neavei and S. damnosum in the Elgon area and on the lower slopes of the Ruwenzori. It is intended to build a dam for a hydro-electric scheme at Kamdini on the Nile between Atura and the Murchison Falls and an attempt was made to eradicate Simulium in this stretch of the Nile. Unfortunately whilst temporary clearance of the main river was obtained, complete eradication in the tributaries was unsuccessful and at the end of the year repopulation of the Nile with flies had occurred.

(Uganda, Report for the Year 1959. London H.M.S.O. 1960.)

WEST AFRICA

Stored Products - Insecticide Measures

Cocoa: On the advice of West African Stored Products Research Unit pest control measures are now confined to a limited amount of misting with pyrethrins in conjunction with fumigation measures. Spraying of warehouse walls with DDT during the moratorium period between seasons is an annual routine measure. Cocoa is shipped as soon as possible after fumigation to avoid the need for measures to prevent reinfestation. Early shipment is not always possible, however, and this has led W.A.S.P.R.U. to continue investigations on methods of protecting fumigated cocoa.

Groundnuts: The Pest Control Unit of the Produce Inspection Division of the Ministry of Agriculture, Northern Region, have continued routine control measures against Tribolium castaneum, i.e. the regular spraying of the external surfaces of groundnut stacks with a suspension of malathion wettable powder, and the treatment of the underside of sisalkraft dunnage with a 4% malathion dust as described in the 1958 W.A.S.P.R.U. Annual Report (paragraphs 94-6).

Grain: (1) Corn: Various experiments are in progress. Acting on requests from the Ministry of Agriculture, Northern Region, for information regarding the protection of farmers corn and on small-scale storage in general, W.A.S.P.R.U. Kano, and the Agricultural Research Station, Samaru, have commenced trials in which the effectiveness of a 0.5% BHC formulation is being investigated. Trials involving the dusting of unthreshed guinea corn in rumbus with BHC at the rate of approximately 2 p.p.m have been carried out in conjunction with entomologists of the Agricultural Research Station, Samaru. In Kano, the corn has been stored in three mud-built rumbus and in six zana rumbus. Corn in three of the zana rumbus was untreated. Corn in the other containers was treated by dusting alternate layers of heads with measured amounts of 0.5% BHC, during the filling operations.

On the basis of results to date it is probable that there is little need for insecticidal protection during the dry season, i.e. from time of harvest to May-June, owing to the low rate of insect development. At the beginning of the wet season, however, the BHC content of the corn is so low that it gives little protection in the case of zana rumbus. Further trials have been planned for the next storage season in which a malathion dust, an inert dust, and also heavier initial admixture of BHC dust, will be applied to corn at the normal time of loading into rumbus.

(2) Maize: The effect of insecticides on maize in cribs has been examined in trials at Ibadan and Ilora. In the latter case dosage rates of 8 p.p.m. malathion and 5 and 10 p.p.m. lindane quality BHC were used. Each treatment was replicated four times, as was the control. Samples are to be taken monthly for moisture content, germination, and insect damage, and every two months for contamination. The maize was placed in the cribs within a week of harvest, after sun-drying to about 18% moisture content. Moderate infestation by Calandra oryzae and Cathartus cassiae (Kohe.) was present from the field, and about 12% of grains were damaged. Initial analysis for contamination by BHC after shelling and winnowing the grain to remove dust, was carried out using the Schechter-Hornstein method and no measurable amount of insecticide was found. The experiment is planned to last six months.

As regards silo storage of maize it is stated that the control of insect pests is simpler in the pre-cast concrete bin because it can be sealed very easily, making fumigation more efficient; the continuous construction between wall and roof prevents the entry of crawling and flying insects.

New Technique for Suspension Testing

A new method of applying suspensions of wettable powder to absorbent surfaces, such as mud, and concrete, has been developed, and consists basically of introducing, by pipette, a known quantity of the suspension to the surface to be treated, the liquid being restricted to a fixed area by means of a cylindrical lamp-glass, and leakage being prevented by "Plasticine" or putty applied around the base of the cylinder. As the liquid soaks into the absorbent surface a uniform deposit is left as a result of the filtering process. The strength of the insecticidal suspension is so arranged that when a convenient quantity is pipetted into the cylinder, the required deposit will be obtained.

Insecticides such as malathion (which breaks down quickly when applied to an alkaline surface) have usually been tested on filter papers which are not readily adaptable to the method described in the previous paragraph owing to the distortion produced on wetting the papers. As a solution to this problem, neutral surfaces have been made by pouring small quantities of plaster of paris into the cylindrical lamp-glasses placed on a horizontal glass sheet. The porous disc formed when the plaster sets, is very suitable for treatment with insecticides in manner described above.

Persistence on Concrete

Concrete blocks were treated at various rates with malathion and diazinon emulsion concentrate formulations. Continuous exposures of Tribolium castaneum adults, always resulted in very low mortalities, the diazinon treatments giving only slightly better results than malathion. Both insecticides lost any insecticidal effect on the concrete surfaces within a few days. Pre-treatment of concrete surfaces with calcium sulphate (used as a neutral whitewash) increased the initial toxicity of both insecticides but this effect disappeared within a week. It was concluded that diazinon was only slightly better than malathion and that neither insecticide was suitable for giving a residual effect on alkaline surfaces such as concrete walls.

In another experiment formulations of several insecticides were compared, including:

Malathion 50% wettable powder (w.p.)
and 40% emulsion concentrate (e.c.)
Diazinon 20% w.p., and 10% e.c.
Dieldrin 50% w.p. and 20% e.c.
γBHC 50% w.p.

Both dieldrin treatments yielded promising results. This insecticide was obviously little affected by the alkaline conditions on concrete, and its insecticidal persistence was long. Mortalities in excess of 90% were produced after 15 and 30 days, and in excess of 50% after 30 and 75 days, by the wettable powder and emulsion concentrate, respectively. When the experiment was terminated after about $3\frac{1}{2}$ months, a high proportion of test insects were still being rendered inactive by the emulsion concentrate treatment, although the lethal effect was negligible.

Pyrethrum-Treated Sacking

In an experimental trial, five circles of hessian sacking, backed by absorbent paper resting on porous concrete blocks and enclosed by open glass cylinders of similar internal basal area were treated with 2.5/25% wt pyrethrins/piperonyl butoxide wettable powder at 10/100 mg/sq.ft and at half this dosage. Ten *Tribolium castaneum* adults were placed on the sacking in every cylinder and counts of knock-down made after 1 and 24 hours. Mortalities were recorded after 48 hours. The operation was repeated daily for three days and then weekly until the toxicity became reduced.

It was found that the 10/100 mg deposit on hessian sacking gave a satisfactory kill of T. castaneum for up to three weeks. The 5/50 mg dose also was effective but the duration of persistence was reduced in rough proportion to the concentration. there was no known-down in the control.

(West African Stored Products Research Unit. Department of Marketing and Exports, Nigeria, Annual Report 1959.)

NEWS ITEMS FROM OTHER PARTS OF THE WORLD

COSTA RICA

Cacao

The Effect of DDT and Dieldrin with and without Bordeaux Mixture on the Yield and Pollination of Bearing Cacao: As pointed out in the Annual Report for 1957, it has been suggested that pollination is a serious limiting factor in cacao production in Costa Rica. A very limited amount of work has been carried out on cacao pollination, although it is generally accepted that pollination is almost entirely affected by insects, probably by midges of the genus Forcipomyia, and few field trials of insecticides have been carried out in Central America. As a preliminary approach to this field of work and to the use of insecticides generally until such time as a full-time entomologist is available for the work, a new field experiment was begun in April 1958 to test the effect of three insecticides on cacao trees. L. R. Siller is in charge of the experiment.

The treatments are applied as sprays every 30 days, and consist of:

a) Control,
b) DDT, ¼ gallon of 25% emulsifiable concentrate in 100 gallons of water,
c) DDT, concentration as in (b) in 4-4-50 Bordeaux mixture,
d) Dieldrin, 1 pound of 50% wettable powder in 100 gallons of water,
e) Dieldrin, concentration as in (d), in 4-4-50 Bordeaux mixture,
f) 4-4-50 Bordeaux mixture.

About one gallon per tree of the spray mixture is applied monthly. Treatments are arranged as three replications in a randomised block design. The trees are seedlings about 42 years old, and there are an average of 70 trees per plot, the number varying between 60 and 83.

Data taken include numbers of mature pods, mature but usable pods infected with Phytophthora palmivora, young fruits infected with Ph. palmivora, pods lost by cherelle wilt, and pods lost by other means.

It is too early to judge results, since many of the pods were set before the application of treatments, and any improvement of vigour will take time to be reflected in crop production, but the effect of DDT appears promising.

From September 1958 onwards one tree in each plot, selected for uniformity of production on the basis of yield data available for the previous 7 years, was hand-pollinated twice weekly, pollinating five flowers on each occasion (or less if there were less than five flowers). Of course none of the hand pollinated fruits had matured by the end of the year. More detailed data is taken from the hand-pollinated trees, including number of flowers pollinated by hand and naturally, and detailed records of the maturation or cause of loss of each hand-pollinated fruit; similar detailed data is taken from a comparable tree also selected for uniformity in each plot, but not hand pollinated.

The experiment should provide valuable leads concerning the effects of the insecticides on productivity, on the spread of Phytophthora palmivora, and on insect populations and insect damage; as to whether or not the efficiency of natural pollination is a limiting factor in yields at certain times of the year; and about the effect of the insecticides on pollinating insects.

Phytophthora palmivora

This disease continues to be highly destructive, is the most widespread disease of cacao, and at present causes greater losses in Latin America than any other. Further reports on previous work on the disease were published during the year.

It has been shown previously that Bordeaux mixture applied in high volume was invariably better than other fungicides tried.. Nevertheless, Bordeaux does not give complete control and appears to have some phytotoxic effect in burning young leaves and sometimes giving a crinkled and hardened appearance to older leaves. The spray treatments were always applied on cycles of not less than 30 days; the cost of shorter cycles at high volume would be prohibitive. In recent years low-volume spraying techniques have been rapidly developed commercially and widely used on other crops and occasionally on cacao, and this should make shorter cycles of application with other fungicides and thus more efficient control economically possible.

Small Scale Screening of Fungicides for the Control of Phytophthora palmivora: This work had continued, following the method described in previous reports. It has been confirmed that Gobre Sandoz is equally as effective as Bordeaux mixture, and the fungicide is to be field tested on a larger scale.

The recent development of new organic fungicides effective against Ph. infestans may be of great importance. Preliminary reports indicate that these are less phytotoxic than Bordeaux mixture. Further small scale experiments are being prepared, using the same methods as with the other fungicides, and it is planned to compare the effect of newly developed stickers in combination with low-volume sprays.

A graduate student is studying the effectiveness of different concentrations of orchard spray oil in the laboratory, in the greenhouse and in the field in the control of the disease. To date, laboratory and greenhouse work had indicated surprisingly effective control of pure cultures of the fungus grown on agar and on treated pods with the use of low concentrations of oil in water. Work is now in progress in the field to determine the relative effectiveness of spraying the best concentrations of oil found by laboratory and greenhouse work on mature trees and to determine if there is any harmful effect.

Field Trials of Low-Volume Spraying for the Control of Phytophthora palmivora: It has not yet been possible to initiate these trials, since the available staff was fully occupied with other work. However, with the arrival of A. J. Hansen in October, and of Dr. Russell Desrosiers, a well-known cacao pathologist, to take charge of the cacao programme of STICA, Ministerio de Agricultura, Costa Rica, plans were being drawn up at the end of the year of cooperative field experiments by the Cacao Center and STICA on this subject, using Cobre Sandoz and other fungicides which have proved effective in the small scale trials, orchard oils, stickers, and comparing the effectiveness of different types of low-volume sprayers.

Resistance and Susceptibility of Cacao Types to Phytophthora palmivora: The best long-term method of control of Phytophthora would undoubtedly be the development of resistant types of cacao, and it is known that a wide range of susceptibility exists.

Experiments are under way to determine the degree of susceptibility of the cacao types which have been selected by the Cacao Center for high yields and apparent low susceptibility. The method used at present consists of exposure of young seedlings to natural infection in seedbeds under old infected trees. Marked differences in susceptibility in seedlings from selected clones have been detected. Clonal cuttings will be tested in similar manner. The method is being developed, and the tests are being augmented with artificial inoculations in the nursery. Preliminary tests are under way to determine the optimal time of inoculation and concentration of inoculum. The liquid media method described by R. G. Orellana for determination of pod resistance will be employed and compared with other possible methods. In this connection, it seems desirable to intensify present studies as to the specific infection habits of the different physiological races of Ph. palmivora, which is reported to attack mainly pods, leaves and chupons in Central America, trunks and branches in Colombia and, almost exclusively, pods in Ghana.

(Inter-American Cacao Center, Annual Report, 1958.
Cacao, (Inter-American Cacao Center) Jan.-Mar, 1959, 4, (1).)

IRISH FREE STATE

Potato Virus Antiserum: A severe tuber necrosis was found occurring in certain stocks of the potato variety Golden Wonder in 1957. Investigation showed that this tuber condition is caused by a virus which is readily transmitted to other varieties by grafting. The exact virus causing the tuber necrosis has not yet been identified but present indications are that it may be a hitherto unidentified strain of virus Y. In attempts to produce an antiserum against the necrosis inducing factor, partially clarified sap from necrotic tuber was injected into rabbits. By this procedure an antiserum against virus X was obtained and it is believed that this is the first time that an antiserum against a potato virus has been obtained using tuber sap as the antigenic source.

(Twenty-Eight Annual Report of the Minister for Agriculture 1958-59.
Appendix - Report of the Agricultural Department, University College, Dublin, for the Year 1958-59).

MOROCCO

Tests to determine the susceptibility of Anopheles labranchiae Fall in Morocco have shown the existence of marked dieldrin tolerance. No satisfactory explanation as to the origin of this phenomenon is offered, except that it may have arisen through the application within the area of insecticides similar to dieldrin, for agricultural purposes.

(G. Sacca, WHO Communication.)

SOMALILAND

Malaria: The World Health Organisation team continued its investigations throughout the year. The team has taken over supervision of routine residual spraying of dwellings in endemic foci and along the southern boundary of the Country. In the former, 326 structures were sprayed using DDT at 200 mg/sq. ft. twice during the year. In the villages along the southern boundary of the Country a single spraying was carried out shortly after the outbreak of the main rains in April, when 1,268 permanent structures and 1,552 portable huts were sprayed. No effort was made this year to locate and spray portable huts in the southern grazing area away from the permanent settlements, as the conclusion has been reached that residual spraying of these structures is not very effective due to: 1) loss of deposit due to buffeting action of wind and percolation of rain, 2) frequent dismantling - on re-erection the position of mats exposed inside huts often changes, 3) mechanical action of inhabitants in rubbing against walls, 4) masking of insecticide by soot from cooking fires. It was decided to follow up the single spraying by larvicidal measures directed at the breeding places in tanks in the villages.

Study of Anopheles gambiae: A small settlement of three portable huts was established in an area of very scattered low density population, located 24 miles north of Hargeisa, in which A. gambiae has almost always been found. Two members of the staff reside in the settlement and spend a night in each hut in turn. In the morning the staff make a knockdown catch in the house they occupied during the night and classify any A. gambiae collected into four groups: unfed, fed, gravid, half gravid. The mosquitoes of the first two categories are dissected to remove the ovaries which are dried for subsequent classification into parous and non-parous. When possible the stomach contents of engorged mosquitoes are placed on filter paper for precipitin tests.

Eventually one house will be sprayed with DDT, one with BHC and the third provides a control. In this way it is hoped to obtain information regarding behaviou of A. gambiae in treated and untreated huts, persistence of deposited insecticide, and an idea of the natural longevity of the vector in that area.

Note: The reports of the project leader of the Malaria Control Scheme contain repeated references to the manner in which the team's work is hampered by lack of cooperation from the public, an example being the refusal of owners of water tanks to undertake the regular use of the larvicidal briquettes with which they are supplied. Consequently the main effort in health education has been directed towards enlightening the public on the method of spread of malaria, the measures being taken by the Health Department to control it, and the measures that can be taken by individuals to protect themselves and their families.

Relapsing Fever: Six cases of tick borne relapsing fever occurred during the year in Hargeisa. Some of these had been infected in the town and anti-tick measures were instituted in the areas from which the patients came.

(Health Department, Annual Report 1959.)

SUDAN

Proposed Insecticide Legislation: In the last four years the number and quantities of highly toxic insecticides increased enormously. Before then comparatively safe insecticides like DDT and BHC were mainly used against cotton pests and for public health purposes. As more resistant pests started to appear in the cotton cultivation areas more and more toxic insecticides were imported for their control; things like parathion, endrin, toxaphene, "Metasystox", "Rogor" and many other similar compounds.

It was then obvious that in the absence of any adequate system of control, the use of such compounds is liable to constitute a serious public health hazard, specially among farmers used to DDT and ignorant of any dangers inherent in more toxic agricultural chemicals. It was thus felt by Public Health Authorities that it was high time that laws and regulations were made to ensure public safety in importing, conveying and applying toxic insecticides. This may need a special ordinance and a special controlling authority in the form of something like a Pesticide Board under the Ministry of Agriculture on which the Ministries of Agriculture, Health, Commerce, Industry and Supply, Agricultural Boards and the Agricultural Bank are represented.

Meanwhile, insecticides come under the Prohibited and Restricted Goods Ordinance and their import is subject to a licence issued by the Director, Medical Service for each consignment entering the country. For the import of toxic insecticides the licence is now being given subject to the importer signing an undertaking to observe certain conditions in sale, storage, conveyance and application. This will offer adequate temporary protection to the public until the proposed insecticides ordinance is passed.

(Wellcome Chemical Laboratories, Medical Services, Ministry of Health, Khartoum. Annual Report of the Government Analyst for the Year 1958-1959.)

TURKEY

Olives - Diazinon Residues: Control of the olive fly, Dacus oleae Gmel, is effected by spraying the trees with a diazinon emulsion. For residue assessment, the content of olive fruits is extracted with benzene. The extract is cleaned by passage through an active carbon column. Afterwards the benzene is removed, first by evaporation in the water-bath followed by vacuum distillation. The diazinon is determined by cholinesterase inhibition measurement. It has been found that as little as 0.05 μg of the chemical can inhibit cholinesterase. Reliable results are reported within the range 0.5 - 10 μg.

Cotton Dust Analysis: Cotton dust, containing γ BHC and DDT are commonly used for plant protection in Turkey. Routine analysis of these dusts by a method based on partition chromatography is stated to give satisfactory results.

Pistachio - Methyl Bromide Residues: Residues in dried fruits of pistachio fumigated with methyl bromide have been determined by a technique based on Dudley's method (J.econ.Ent., 44, (3), 384.) Potassium chromate was used as the oxidising agent in place of chromic oxide; the oxidation time was increased from 25 minutes to 1 hour.

(Bitki Koruma, 1960, 1, (3).

UNITED ARAB REPUBLIC (SOUTHERN REGION)

Cotton Pest Research: Satisfactory control of *Agrotis ypsilon*, the greasy cutworm, was obtained with the following pre-planting treatments.

(1) Granular toxaphene 10%, dieldrin dust 50%, toxaphene dust 20%, DDT dust 10% and cotton dust at 50, 10, 25, 20 and 15 kilograms per feddan[ø] respectively in soil applications.

(2) Dieldrin 20%, toxaphene 60% and DDT/lindane 30/9 at 2.5, 3 and 2.5 litres per feddan respectively (arranged in descending order of effectiveness) applied as sprays.

(3) Satisfactory control of its larvae is reported using any of the following for soil treatment before planting:

(a) Granular endrin (2%) at the rate of 25 kg per feddan.
(b) Granular heptachlor (5%) at the rate of 20 kg per feddan.
(c) Granular toxaphene (10%) at the rate of 50 kg per feddan.
(d) Dieldrin (20%) at the rate of 20 and 25 litres per feddan.
(e) DDT (25%) at the rate of 20 and 16 litres per feddan.
(f) Heptachlor at the rate of 6.3 and 8 litres per feddan.
(g) Endrin (19.5%) at the rate of 2.5 litres per feddan.

Studies on the effect of some new organo phosphorus compounds on the cotton leaf worm and the cotton bollworms revealed that 'Lebaycid' (O-O-dimethyl-O-4(methyl mercapto)3 methyl phenyl thiophosphate at two

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[ø] 1 feddan = 1,038 acres.

litres per feddan was more effective than both methyl and ethyl 'Gusathion' against the above pests. The methyl and ethyl derivatives of 'Gusathion' were about equally effective against newly hatched larvae of the cotton leaf worm. The three materials, however, were not particularly effective against these larvae. For satisfactory control of the cotton leaf worm on cotton under Egyptian field conditions, it is deemed essential that the above materials be used in combination with more effective chlorinated hydrocarbons of longer residual effect. The fact that plots treated with ethyl 'Gusathion' yielded comparatively lower yields in spite of high degree of bollworm control should warrant further studies.

In tests involving the comparative effect of various acaricides on the two spotted spider mite, Tetranychus telarius complex, on cotton, it was shown that Ciba 570 was quick in action and its effect lasted for 20 days, 'Erisite' was slow in action and its effect lasted for only 17 days, 'Tedion' and 'Kelthane' were quite effective, though the last material proved quicker and a little bit more effective. The last two materials remained effective for at least 29 days. No build up of mite population followed the use of toxaphene. To be sure, results indicate that that material has an acaricidal effect.

Corn Borers: Spraying corn plants with DDT (50%) wettable powder four times, when the plants are 20, 30, 45 and 60 days old, is still the most effective method for borers control (Sesamia cretica, Chilo simplex and Pyrausta nubilalis.) Heptachlor (7.5%) granules in parallel applications also gave satisfactory results. Less satisfactory results were obtained with toxaphene (10%) granules and poor results were obtained with dipterex (2.5%) granules.

(Ministry of Agriculture, Plant Protection Department, Report on the Activities of the Plant Protection Department for the Year 1959.)

HERCULES AC-5727

Hercules Powder Company, Wilmington, Delaware.

This compound (m-isopropylphenyl methylcarbamate) is a grey crystalline material with a slight odour and a melting point of 76°C. It is soluble in acetone, alcohol, and xylene but insoluble in water. It is not yet available commercially, but is being prepared in small quantities for testing purposes. The acute oral LD_{50} to white rats was first reported to be about 45 mg/kg, but more recently as about 15 mg/kg.

On the basis of preliminary tests it is reported as being very promising for use as a persistent insecticide against Anopheles quadrimaculatus Say. It has also been shown to be highly effective against other mosquitoes including Anopheles albimanus Wied., Aedes taeniorhynchus Wied. and Aedes aegypti (L.)

In laboratory tests on plywood panels, with A. quadrimaculatus as test insect, the compound was highly effective at dosages as low as 1 mg/sq. ft. for at least 20 weeks. Increasing the amount applied reduced the exposure time required to kill. Exposures as short as 1 minute were highly effective on boards treated at 100 mg/sq. ft. Hercules AC-5727 was more effective than DDT, malathion, dieldrin, or Bayer 29493 (Baytex). Its outstanding characteristic is the rapidity with which it acts. The highest knock-down with DDT, malathion, dieldrin, or Bayer 29493 after 30 minutes of continuous exposure on 100 mg deposits was 21% whereas a 1-minute exposure to Hercules AC-5727 consistently produced 100% knock-down within 5-10 minutes throughout the first month. Hercules AC-5727, malathion, and DDT did not have long residual toxicity on whitewash or sun-dried brick. Hercules AC-5727 can kill by fumigation, but its volatility rate was too slow to account for the results obtained in these residue tests.

In tests conducted in buildings naturally infested with adults of A. quadrimaculatus Hercules Hercules AC-5727 was still giving excellent protection after 3 months. It appeared to be more durable than malathion but less durable than DDT.

PRESERVATION DEVELOPMENTS LIMITED

Preservation Developments Limited is a new company formed to take over the expanding interest in wood preservation of The Standardised Disinfectants Company - an interest which began nearly half a century ago with Brunolinum wood preserver. Such well-known and well-tried products as Brunolinum, Brunophen, Lyxastan and specialized formulations for log protection manufactured by "S.D.C." will now be marketed by Preservation Developments Limited, who will also provide technical advice on their use. In addition Preservation Developments Limited will devote considerable time and resources to development of new products and methods for protection of timber from pests and disease at all stages from the forest to its final use.

SILIKIL

Velsicol Chemical Corporation, New York, Agent for United-Heckathorn.

Trade name for a microfine, amorphous silica dust, odourless and non-staining which is reported to have good surface adhesion and to remain active under both dry and moist conditions.

The product consists of amorphous silica gel (95.5%-93% silicon dioxide), ammonium fluosilicate (1.5%) and 3% inerts.

The dust is described as being very effective as a preventative treatment against attack by drywood termites, an effect which is attributed to its ability to cause dehydration of an insect by removal of its protective wax layer through a physical absorption process.

Application: Treatment of existing infestation of drywoods is best done with methyl bromide fumigation or brushing or injecting the wood with a 10% pentachlorophenol emulsion. Afterwards "Silikil" dust should be blown throughout the attic from the crawl hole by use of an electric blower or rotary hand duster. Electric blowers can be satisfactorily made from used vacuum cleaners or there are several manufactured blowers, including "Tornado" and "Ever Ready" , specially designed to apply 'Silikil' for drywoods. It is not necessary to close the crawl hole opening during the brief period required to blow the dust. Use at the rate of 1 pound to 1,000 square feet of attic space. Since termites infest wood substructures, the dust should also be blown under the house. In tropical climates where termites infest furniture, wood cabinets and the like, the dust should be blown over the wood surface at the rate of 2 pounds per 1,000 square feet of surface. To prevent infestation of drywood termites of new lumber stored in lumber yards, power poles and fences, dust all wood surfaces at the same dosage or spray on the wood at the rate of 2 pounds per 1 gallon of water applied to 1,000 square feet of lumber.

'Silikil' is equally effective against all other non-subterranean termites, such as damp-woods and powder post termites. It may be used safely around humans and on pets for fleas, and as an effective and long lasting control for other household insects, such as resistant cockroaches, carpet beetles, silverfish, spiders, lice, bed bugs, ants and fleas. Use at the rate of 2 oz. per 100 square feet. It is effective under all temperature and humidity conditions, is free-flowing and will not cake or become lumpy when exposed to high humidity tropical climatic conditions.

TICK CONTROL WITH SEVIN

Klipfontein Organic Products Corporation, South Africa, quoted in Union Carbide's "Agricultural Chemicals Digest", 1960, 2, (2), 5-6.

From the commercial point of view the cattle farmer is one of the most important customers of manufacturers and formulators of insecticides. For the scientist, the tick problem remains a challenge which is far from being solved. Although it is possible today to keep a herd of cattle free of tick-transmitted diseases, the tick population in Africa has not been reduced: on the contrary, in the opinion of many experts the problem is becoming more serious.

In Africa the following species of ticks are encountered:

1. Boophilus decoloratus: Since it is a one-host tick, it is prone to acquire resistance to acaricides. It has become resistant to arsenic, benzene hexachloride and DDT and, in certain areas, can only be controlled by organo-phosphorus dips or sprays and by 'Sevin'.

2. Amblyomma hebraum: The transmitter of Heartwater, a disease which makes the movement of cattle into areas heavily infested with this species of tick a problem. The wounds it causes, because of its long mouthparts, are readily infested with screw worm. Until the arrival of 'Sevin', the best killer of this tick was toxaphene. Both of these chemicals are equally effective.

3. Rhipicephalus appendiculatus: The carrier of East Coast Fever and Theilerosis has a very short life cycle, which makes it necessary to dip or spray at intervals of less than a week. Here an acaricide with a long residual effect is required. 'Sevin' is effective against this tick, but the results appear to be less spectacular than with BHC, which has, however, the disadvantage of a very short residual effect.

4 and 5. Rhipicephalus everetsi and Hyalomma truncatum are ticks which are extremely difficult to control. They attach themselves mainly and almost exclusively on the bare parts of the animal around and underneath the tail. Besides the difficulties experienced in wetting these parts with an acaricide, the residual action of any compound in those areas is negligible as the acaricide fails to adhere to the skin. 'Sevin' has no advantage over the other acaricides in this respect.

'Sevin' is the first pesticide which controls the resistant Boophilus and Amblyomma satisfactorily. The organo-phosphorus compounds used in tick control today are all outstanding for the control of Boophilus, but unsatisfactory as far as Amblyomma is concerned. Toxaphene, on the other hand, which, until the arrival of 'Sevin' was the best killer of Amblyomma, has never been recommended for the control of Boophilus and is definitely ineffective against the DDT resistant strain of this tick.

Since the introduction of the organic insecticides into the field of tick control, it has become increasingly apparent that none of them can be considered equally effective against all common species of ticks in Africa and that it is necessary to combine them for maximum efficiency. It is predicted, therefore, that 'Sevin' will play an important part in tick control in Africa.

The relatively low concentration of 0.075% 'Sevin' recommended today makes it economical to use. In combination with other insecticides, it would be quite possible to reduce this concentration to 0.05%, especially if the aim is to control Boophilus and Amblyomma spp. only. Tests carried out during the coming season (November to May) will prove whether a reduction of the 'Sevin' concentration in combination dips and sprays will give the expected results.

Correct formulation of a cattle dip or spray is as important as the efficacy of the active ingredient it contains. A cattle dip normally remains in a tank for at least a year and must be as effective after this period as it was when it was first put into the tank. This is more easily achieved with an emulsion than with a wettable powder. The best wettable powder will have the tendency to settle in the tank during the weekly intervals between dipping days. It is common knowledge that it is not easy to re-suspend the settled powder, which is partly covered with dirt carried into the tank by the animals. The fine particles of the wettable powder are often covered with a thin layer, made up of organic matter, which prevents the active material from coming into direct contact with the tick and decreases its efficacy to practically nothing.

Now that the value of 'Sevin' has been assured in the dipping field, research to improve the wetting properties of the formulations already available should be commenced.

Although a definite trend can be observed among farmers in Africa to replace their plunge tanks with spray races, the majority of farms still have plunge tanks. A very lively activity of micro-organisms are found which thrive on the organic matter available in the tank. It has been proved that these micro-organisms can attack the acaricide in the tank as well. Dipping tanks containing 'Sevin' as acaricide develop a very strong odour of hydrogen sulphide which is not present when other dipping materials are being used. It should be emphasized, however, that this decomposition taking place in the tank is not related to a decrease of the efficacy of 'Sevin'.

LEAFLETS

CHEMICAL SOIL STERILIZATION

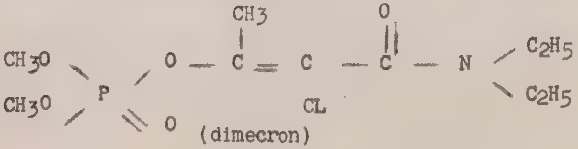
Murphy Chemical Company Ltd. Wheathampstead, St. Albans, Herts.
July 1960, pp.16.

Brochure giving particulars of the products marketed by this firm for soil sterilization, ("Vapam", formaldehyde, etc.) and for eelworm control ("D.D", parathion). Slight modifications have been made to the methods for applying "Vapam" (based on sodium methyl dithiocarbamate).

DIMECRON

CIBA Ltd., Basle, Switzerland.

Leaflet (printed in English, French and German) describing the chemistry, properties and uses of Dimecron, formerly known as Ciba 570, which contains as active ingredient 2 chloro-2-diethylcarbamoyl-1-methylvinyl-dimethyl phosphate, for which the common name is Phosphamidon.



(dimecron)

HEPTACHLOR

Velsicol Chemical Corporation, New York.

Several leaflets have been received describing the use of this insecticide in various applications including: the control of mosquitoes, grasshoppers, spittlebugs, cutworms and armyworms, wireworms and other soil insects; use on peanuts, cotton, corn, tobacco and alfalfa; and in admixture with fertilizer.

VEGETABLE PEST CONTROL

Shell International Chemical Co. Ltd. 30 pp.

Colourfully illustrated booklet presenting control measures incorporating this Company's insecticides against the more common insect pests. Spraying schedules are based on the maximum intervals deemed likely to be necessary to conform with residue legislation, climatic conditions and application methods.

NEW PUBLICATION

NUCLEAR ENGINEERING ABSTRACTS

This is the title of a new abstracts journal, of which the first number appeared in July. It is to be published quarterly by a firm called Silver End Documentary Publications Ltd., 9-11 Tottenham Street, London, W.1. Although the subscription is rather high (£6-6-0 post free for four issues per annum) the abstracts are tidely presented and the field covered by the journal is much wider than is indicated in the title, including sections on Mechanical & Production Engineering, on Electrical & Electronic Engineering, on Physics & Chemistry, on Heat, on Metallurgy, along with such specialised topics as Radiation in Industry & Agriculture.

In a short foreword it is stated; "The journal is addressed to the Engineer engaged in nuclear work; to the Scientist employing nuclear instruments and machines or, for reasons of his activities, generally interested in engineering; to the Manufacturer and Operator of nuclear plant for all purposes including auxiliaries; to the Industrialist planning to enter the field and wishing to familiarise himself with conditions."

The editorial and printing staff are to be complemented on the high standard of presentation which they have set themselves.

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G. Unterstenhofer. Hofchen-Briefe, 1960, 13, (1), 44-52.

O,O-dimethyl-O-4-(methylmercapto)-3-methylphenylthiophosphate is the active component of the new insecticide 'Lebaycid'. A report is given in this paper on its biological efficacy.

With an LD50 to the rat of 230 to 250 mg/kg per os, it ranks among the organic phosphoric esters having a low order of mammalian toxicity.

The active material features a wide spectrum of activity as proved by the findings of tests on approximately 30 species of Diptera, Homoptera, Lepidoptera, Coleoptera and other orders of insects. It possesses a moderate acaricidal potency and is well tolerated by plants.

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THE ARTHROPOD-BORNE VIRUSES

Report of the Medical Research Council for the Year 1958-1959.

The arthropod-borne or 'arbor' viruses are, despite their great diversity, classified as a single group because of a characteristic common to them all - their life span includes a period of growth in an insect host. The insect, which may be a blood-sucking mosquito, tick, or sand-fly, becomes infected when it feeds upon a vertebrate host at a time when virus is present in the host's blood stream. After the virus has been taken up by the insect there is usually a latent period of 10 or 12 days, during which the virus is multiplying, before the insect can transmit virus by feeding upon another susceptible subject. The virus appears to be harmless to the insect, which remains, however, infective for the remainder of its life. Since an infected mosquito may bite every second or third day and may live for three months or more, the potentiality for spread of these viruses is considerable. The arbor viruses are classified in a different group from that of other animal viruses which, although they may be spread by insects, do not multiply in the vector; the myxoma virus, for example, is transmitted by the bites of mosquitoes or rabbit fleas in a purely mechanical manner without any multiplication in the insect. Plant viruses, of which a number are arthropod-borne, are not considered in this review.

It is the non-arthropod cycle, which may involve man, wild and domestic animals, or birds, that makes the arbor viruses important to man. The viraemic phase in the host is usually short, lasting as a rule two to five days, and it is followed either by the development of immunity and the disappearance of virus from the blood stream, or, in certain severe infections, by the death of the host. Coincident with the viraemia the clinical symptoms of disease, if any, make their appearance; many virus attacks are symptomless. When certain tissues are affected particular disease states may arise. Thus, in yellow fever the liver is typically involved producing jaundice, although in many cases of yellow fever there is only a general reaction with fever and malaise. Certain viruses, such as Murray Valley encephalitis virus, have an affinity for nervous tissue and may produce encephalitis. Others may produce lesions in the skin, for example the rash characteristic of certain types of dengue, or a haemorrhagic disease such as has been reported from Thailand (Hammon, et al., 1958). Many human infections with arthropod-borne viruses are without any characteristic symptomatology, and produce only a mild systemic illness or no overt disease at all. The diagnosis of most of these virus fevers is almost impossible without the assistance of a laboratory, and even with a first class laboratory the precise identification of a virus may be an extremely difficult and time consuming process.

World Chain of Laboratories.

Scattered throughout the tropics, and in a few countries in the temperate zone, are laboratories or units in which the study of arthropod-borne virus infections is the principal interest. In Nigeria and in Uganda, laboratories were established many years ago by the Rockefeller Foundation as part of their programme of research on yellow fever. These are now known respectively as the West African Council for Medical Research Laboratories in Lagos, and as the East African High Commission Virus Research Institute in Entebbe. Whilst yellow fever studies continue in both laboratories several new viruses have been isolated, of which Chikungunya (Robinson, 1955; Ross, 1956) and Ilesha (Annual Report, 1958) are the most recent. In South Africa, a unit of the Rockefeller Foundation and the South African Institute for Medical Research have been particularly active in Tongaland, where a number of new viruses have been described (Smithburn et al., 1959). In the Far East where dengue and Japanese B encephalitis are the two most important human infections, a third potentially important reservoir of infection was uncovered in ticks (Smith, 1956). A related tick-borne virus was also isolated from human infections, some of them fatal, by workers at the Virus Research Centre operated by the Rockefeller Foundation and the Medical Research Council of India at Poona (Work, 1958). In the West Indies, the Regional Virus Laboratory established by the Rockefeller Foundation in collaboration with the Government of Trinidad and Tobago described another new virus (Mayaro) capable of infecting man (Anderson et al., 1957) and linked up an earlier strain from South America, Ilheus virus with human infections. In the United States of America the Rockefeller Foundation in New York have for a number of years provided a focus for research upon arthropod-borne viruses, and active groups are also present in Pittsburg, Washington, in California and a number of centres elsewhere. In Europe, tick-borne viruses of the group are under investigation in Russia, Czechoslovakia, Holland, and Scandinavia. In the British Isles, a number of different aspects of arthropod-borne virus infections are being studied at the National Institute for Medical Research, at the London School of Hygiene and Tropical Medicine, and at centres in Belfast and Glasgow.

The Council's interest in this group of viruses is both direct and indirect. Through the Colonial Medical Research Committee, which is responsible jointly to the Secretary of State for the Colonies and to the Council, and through the Council's Committee on Virus Diseases in the Tropics, research work on these viruses is directly related to that on viruses generally in the British Colonies; and indirectly the same work has an important bearing on the research in virology, supported by the Council, which is in progress in this country.

Ten years ago the isolation of a new virus in the Tropics was something of an achievement. Now it has become almost an embarrassment, and most tropical laboratories have several new or unexamined viruses stored under deep freeze conditions awaiting study. In the Annual Report for 1959 of the Rockefeller Foundation Virus Laboratories it is stated that 116 arbor viruses have been isolated, 30 in Africa, 25 in Asia, 53 in America, 15 in Europe and 1 in Australia. Many of these are common to more than one of these regions. Fortunately, in the last five years a number of advances have been made in techniques for the study of these viruses.

New Methods of Identifying the Viruses

Until recently almost all the arthropod-borne viruses were isolated by inoculation of mice, and viruses were identified by demonstrating that they could be rendered non-infective for mice after incubation with sera taken from animals which had recovered from infections with the particular virus under study. Antibodies also were demonstrated in human populations or in animals or birds by the same techniques, and these methods necessitated the use of very large numbers of mice. The demonstration that many arthropod-borne viruses could, under carefully controlled conditions, bring about the agglutination of certain avian red blood cells, and that this agglutination could be inhibited by antisera, greatly simplified laboratory procedures for their identification.

Classification of the Viruses

By this method it was shown by J. Casals and others, working at the Rockefeller Foundation Virus Laboratories in New York, that about half the known arthropod-borne viruses could be placed in one of three serological families which they designated Groups A, B and C (Casals, 1957). Five Group A viruses are known to occur on the American continent - the three equine encephalomyelitis viruses, which produce occasional disease in man, and two recently defined agents, Mayaro (Casals and Whitman, 1957) and Uruma viruses (Schmidt et al., 1959); and at least four Group A viruses are present in Africa - Semliki Forest virus in Uganda and Nigeria, Sindbis virus in the Nile valley (Taylor et al., 1955), Chikungunya virus in Tanganyika, and Middleburg virus in South Africa. Group B is a larger family of these viruses and has an even wider distribution, including as it does yellow fever virus, dengue, Japanese B encephalitis, and the Russian Spring-Summer encephalitis - louping ill group of viruses. Members of the latter group have been found in the U.S.S.R. and in other parts of Eurasia. These agents are transmitted by ticks and can cause human disease of varying clinical severity. Louping ill is the only representative of the arthropod-borne viruses known to occur naturally within the British Isles, and recent evidence from Northern Ireland suggests that it may produce a 'poliomyelitis-like' illness in addition to the influenzal or encephalitic picture previously described (Likar and Dane, 1958). Although tick transmission is probably the usual means of spread, infection may be transmitted by drinking infected goat's milk (Van Tongeren, 1955; Smorodintsev, 1958). Group C viruses have so far been isolated only in South America, although antibodies to members of this group have been found in the sera of residents of West Africa.

Epidemiology

A full understanding of the epidemiology of the arthropod-borne virus infections implies a detailed knowledge not only of the manner in which human infections are acquired, but also of the way in which the virus is maintained in the different insect hosts, and of still further cycles of infection involving perhaps animals or birds. The ecological factors concerned with the spread of a mosquito-borne virus in a tropical forest are obviously very different from those which apply to the spread of a tick-borne infection in Europe, and a detailed consideration of the many and complex variables is impossible here. These factors have been suitably discussed in a recent review (Smith, 1959). Yet recent serological studies have revealed close relationships between viruses such as yellow fever and louping ill, which have utterly different ecological backgrounds. Evidence is accumulating that the existence of shared antigens and the production of group antibodies may be of considerable epidemiological importance. The greater resistance of the African to yellow fever, as compared with the unvaccinated European was in the past explained as a genetic difference; it now seems much more probable that the tolerance displayed by many Africans is the results of prior infection with one or more Group B viruses serologically related to yellow fever virus and resulting in a partial cross immunity. Such a partial protection has been demonstrated in monkeys infected with Uganda S virus (a Group B virus isolated in Uganda) and subsequently challenged with yellow fever virus (Macnamara, 1953). The close association between antibodies to yellow fever and a number of other Group B viruses has been demonstrated in Trinidad (Theiler and Casals, 1958) and in West Africa (Macnamara et al., 1959). The same mechanism of serological overlapping may be used to explain the geographical zoning of infections with different arthropod-borne viruses. Thus, the absence of yellow fever from the Indian sub-continent and from the whole of the Far East in spite of the wide distribution of a suitable vector, may be explained by the presence in these areas of a widespread immunity to other Group B viruses such as dengue and Japanese B encephalitis, and perhaps in certain areas West Nile and Nyasanur Forest disease (Work, 1958). It may well be that some of the viruses isolated in the Tropics which have in the past been regarded more as pathological curiosities than as agents of human diseases play an important part in immunizing man against the effects of more virulent infections.

Tissue Culture Techniques in Assay of Virus and Antibody

Although the existence of shared antigens may simplify the initial stage of placing an unidentified virus in the right group by its reaction in haemagglutination inhibition tests, and although field studies have shown the value of this technique in the examination of human sera (Porterfield, 1954, 1956) the presence of broad group reactions complicates the interpretation of antibody studies based upon this procedure. For a number of reasons neutralization tests are to be preferred for quantitative and other critical estimations. These may be carried out in mice, as has been standard practice for many years, but recently tissue culture techniques have been developed to a stage at which they may supplant mouse tests. When a preparation of chick embryo cells is exposed to infection with a suitable dilution of virus and subsequently overlaid with a film of agar incorporating cell nutrients, areas of cell destruction or 'plaques' develop; these may be counted to estimate the amount of virus used in the preparation (Dulbecco, 1952). A known amount of virus can thus be incubated with an antiserum and the mixture subsequently assayed by the plaque methods so as to determine the strength of the particular antiserum used. (Dulbecco et al., 1956; Porterfield, 1959a). An even simpler technique can be used consisting of the diffusion of antiserum from a bead placed on the surface of a layer of agar which covers chick embryo cells infected with a plaque-producing virus. If the serum under test contains antibody against the virus under study, plaque formation is prevented in an area around the bead (Porterfield, 1960).

It is evident that within the last few years a much better understanding of the inter-relationship of arbor viruses in nature, and of their effect on man, has been gained by means of these newer serological and tissue culture techniques, but this can be regarded as a mere introduction to the advances that might be expected from more sustained and systematic studies in the field and laboratory.

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Note: A previous article on this topic is to be found in P.A.N.S. 'A', Vol. 5, No. 2, pp.218-22.

THE INFLUENCE OF TEMPERATURE, DURING THE TREATMENT PERIOD, ON THE SUSCEPTIBILITY OF ADULT AEDES AEGYPTI.

W. R. BRANSBY-WILLIAMS. Colonial Pesticides Research Unit, Arusha, Tanganyika. pp.13, tables 2.

According to the author, seasonal variations of susceptibility of adult mosquitoes to some chlorinated hydrocarbon insecticides, in some countries, appeared to be due to the temperature differences at the time the tests were carried out. This also seemed to apply for Aedes aegypti adults, tested with dieldrin, at Arusha, Tanganyika.

Tests for susceptibility to dieldrin of laboratory-reared A.aegypti were carried out at the different seasonal temperatures over the period of a year at Arusha, Tanganyika. LC_{50} values varied between 0.84% at 17-17.5°C and 0.077% at 26°C. Exposures in a refrigerator in the dark did not result in LC_{50} values as high as for tests carried out at corresponding room temperatures. Tests where the temperature during exposure was the same, but the post-treatment temperature was different, resulted in similar LC_{50} values for the same exposure temperatures.

The different susceptibilities at the different temperatures are thought to be largely due to the increase in activity with increase in temperature.

DISEASES AND BIOLOGICAL CONTROL IN RHINOCEROS BEETLES

Paul SURANY. South Pacific Commission Technical Paper No. 128. Noumea, New Caledonia, Mar.1960, pp.vi + 62, bib. 82 figs. 6/- stg.

Author's Abstract

Of the tropical rhinoceros beetles two species, Oryctes rhinoceros and O.monoceros, represent potentially dangerous pests of coconut palms and both species are distributed over large areas. While O.monoceros is restricted to the Ethiopian region, the natural habitat of O.rhinoceros ranges over South-east Asia, from where the pest has been repeatedly introduced to islands of the South Pacific region. In the localities of its accidental introduction O.rhinoceros has behaved in a different manner and caused widespread damage and destruction in coconut plantations. In pursuit of an explanation of these conditions, and also as a new approach in the biological control of the species, a survey of the rhinoceros beetle populations has been conducted in Asia and Africa.

Several pathological conditions were found in rhinoceros beetles which proved to be not dissimilar to diseases found in other species of Lamellicornia as well. One of the principal types of disease has been named after Heidenreich who was the first to describe a characteristic pathological condition in Melolontha melolontha from Europe. This pathological picture is rather complex, begins with disturbances or inhibition of lipid metabolism and is accompanied or followed by necrotic or atrophic phenomena in the adipose tissues, in the muscles and in the integument. The second type of dominant disease was named after Maya, who described the dominant symptom in Clemora smithi from Mauritius. The pathology of the host is, again, complicated and the manifestation of certain symptoms may depend on other predisposing factors. The formation of cellular inclusions, sphaeroid, vacuolated corpuscles (SVC), is considered as the principal symptom. In larvae the SVC may partially or entirely fill the volume of the adipose tissue and they may also be formed in the pericardial cells. In adults the diseased hypertrophied larval adipose tissue may occupy most part of the abdomen or the SVC develop in the hyperplastic matrix of the tracheae and/or in the already diseased muscles of the thorax.

These two diseases may also frequently occur in combination with each other when symptoms may be overlapped or altered. Heidenreich's and Maya's diseases, however, in certain combinations may represent a dominant pathological condition in the host which may also be a recurrent pattern in the epizootics of the diseases. With regard to certain regularities in the manifestation, distribution and epizootics of these two diseases the role of infectious agents (of viral nature) is postulated. The pathological conditions may affect all stages of development of the host in which important changes in the physiology may precede the outright manifestation of the diseases. Disturbances in the physiology of the host may be manifested among other symptoms in the formation of macroscopically-visible crystals in the hemocoel or in specific tissues. It is also possible that these crystals of various character may also be formed as a result of a pathological process of different etiology. Abnormal tissue growths, hyperplasia and, probably, neoplasms are of considerable importance in the adults. These tissue proliferations may represent precursors of one or several additional pathological processes of seemingly distinct etiology. Higher organisms such as Rickettsiae, bacteria, fungi, nematodes and mites may also enter the field and may contribute more or less important symptoms to the general pathology of Oryctes.

These pathological conditions, singly or - more likely - in combinations, are now held as responsible for the biological control in Oryctes and, presumably, also in other species of Lamellicornia. The mortality brought about by the diseases may exceed 90% in the various stages of development and the surviving adults may also be affected by pathological conditions of complex nature, though in various gradients of overall severity. Pathological conditions may be observed in all vital organs of the adults except for the somatic muscles and the muscles of the appendages. The dynamics of the host populations seem to depend, to a substantial degree, on the cumulative effect of diseases or the absence of certain factors in an established complement of diseases. The actual manifestation of diseases, and their ultimate effect on the host, however, seem to depend on certain inherent characteristics of the diseases themselves, on unrelated and interrelated factors and chronological succession of pathological processes. It is considered that antagonism, competition, latency, unapparent infections, variations in virulence, trigger effects in superimposed infections and predisposing pathological phenomena of, nevertheless, unrelated etiology play a decisive role in determining the course of development and/or rate of mortality in the host as well as the manifestation of populations as a whole. The effective transmission and dissemination of the diseases, on the other hand, presupposes a certain rate of survival - or capacity for reproduction - in the host, the transovarian route being regarded as the most probable and/or principal mode of transmission of diseases.

Evidence suggests that in the population dynamics of the host the principal types of disease represent regulatory factors which are more or less non-density dependent. It seems that variations in the composition of diseases, including variations in their virulence or susceptibility by the host or the temporary or permanent absence of certain components within the pathogenic processes as a whole may be evidenced in the increased vigor of the host and this condition may lead to population outbreaks. As an additional feature the principal types of disease in the host may entirely inhibit, in effect, the development of certain bacteria and fungi or these organisms are retarded in growth and may produce abnormal forms. The biological control of dynastid beetles and related groups is thought to be achieved ultimately by a complex system of pathological phenomena in relation to environmental factors.

Anticholinesterase Methods for Insecticide Residues

The technique of cholinesterase inhibition as suggested by Michel (J.Lab. and Chem.Med., 1949, 34, 1564) has been employed in the determination of residues of demeton-methyl, "Phosdrin", "Rogor" and "Thimet" in plant tissue. The principle of the method is the observation of change of pH of a buffer solution caused by the release of acetic acid from the hydrolysis of acetylcholine chloride solution catalysed by cholinesterase. The inhibition of this effect can be used as an index of the presence of the anticholinesterase group of insecticides. In spite of the obvious lack of specificity the method is a very useful one and is indeed for some insecticide residues the only one at present available. Dried human blood plasma provides a satisfactory source of non-specific cholinesterase. Several accounts have been published of slightly differing versions of this method and an authoritative standardization of the details is greatly needed.

General Research and Development

The increasing use of poisonous chemicals in agriculture has raised many problems regarding the safeguards which should be applied to the use of insecticides, fungicides and pesticides generally. Under the notification scheme agreed with industry, new chemical substances, or proposed new uses for existing ones, are referred to the Advisory Committee on Poisonous Substances used in Agriculture and Food Storage (Ministry of Agriculture, Fisheries and Food), which recommends the precautions which should be taken to ensure that treated crops contain no harmful residues. The Laboratory is represented on the Advisory Committee and on the Scientific Sub-Committee and its various panels. The work done in the Laboratory includes research on methods for the determination of residues and co-operation in obtaining residue data to assist in the framing of recommendations regarding the use of pesticides.

In devising methods for pesticide residue determinations, the investigations are mainly concerned with the separation of traces of residues, free from all substances which would interfere with the final determination, from large quantities of organic material.

(a) Chlorinated Hydrocarbons, and Fluoroacetamide. Collaborative study of specific methods for the determination of residual quantities of individual pesticides has continued. Colorimetric methods for DDT and benzene hexachloride, both based on a nitration followed by colour development with alkali, have been used, and special attention has been paid to the elimination of interfering substances. In the case of grain and flour a preliminary acid washing of the n-hexane extract, followed by treatment on a column consisting of concentrated or fuming sulphuric acid on diatomaceous earth, has shown promise; this method is also suitable for "cleaning up" extracts of a wide range of other materials including fatty products of animal origin, such as milk and butter. The apparatus already described (Hancock and Laws, Analyst, 1955, 80, 665) for the determination of benzene hexachloride in sewage effluents has been applied to residue analysis; certain modifications have been investigated, such as the use of acetone and alcoholic potassium hydroxide solution (to give a uniphase system) in place of ethyl methyl ketone, and the use of aqueous alkali in the final colour development. The method, as modified, is now being studied by the BHC and DDT panel.

The general method for total organic chlorine determinations referred to in earlier reports has now been published (Sergeant, Analyst, 1958, 83, 335). Determinations are made by a volumetric mercuric oxycyanide procedure following conversion of the chlorine to chloride by a modified Stepanow reduction with metallic sodium; quantities of from 10 to 1000 microgrammes of chlorine can be determined. A further note (Sergeant and Thompson, Analyst, 1959, 84, 251) describes a modified and more rapid method, in which the tetrahydrofuran solvent is replaced by n-butylamine in the reduction stage, with a colorimetric finish using mercuric thiocyanate and ammonium ferric sulphate. The original method was applied to residues of DDT, BHC, chlorbenside, chlordane, toxaphene, methoxychlor, aldrin, endrin and dieldrin. Dieldrin residues in some fats have been determined by both the total organic chlorine method and the much more specific phenyl azide method (J.Agr.Food Chem., 1954, 2, 573); comparative results obtained by the two methods show satisfactory agreement, and the application of the phenyl azide method to residues of dieldrin and endrin in other foodstuffs will be investigated. Methods for the determination of DDT and BHC residues in plant and fatty materials have been published or submitted for publication, and are being studied by the BHC and DDT panel. These methods will be applied in an investigation of DDT and DDD residues in river water and mud for the Water Pollution Research Laboratory.

Work has also been commenced on the determination in fruits of residues of fluoroacetamide and "Thiodan" (a chlorinated sulphur-containing derivative of bicycloheptene).

Fundamental research in the field of polycyclic bridged-ring hydrocarbons produced by Diels-Alder syntheses, with special reference to aldrin, has been continued by the Junior Treasury Research Fellow working in the Laboratory: papers describing this work will be published at a later date. The conversion of certain of these substances into aromatic derivatives by a novel reaction sequence involving disproportionation has been observed. Whilst this fundamental work is not primarily directed to the development of analytical procedures, it has been possible to prepare and establish the structure of derivatives showing intense fluorescence which might be used for analytical purposes.

(b) Organic Phosphorus Compounds. The work on the determination of demeton-methyl residues in vegetables has now been completed and a paper describing the method and some field trials has been published (Laws and Webley, Analyst, 1959, 84, 28). A similar method has been applied to the determination of "Phosdrin" residues in vegetables.

The current research programme on phosphorus pesticides includes an attempt to develop a general method for the determination of residues, based on microdetermination of phosphorus. Such methods require complete separation of the pesticide residue from the naturally occurring plant substances that contain phosphorus, and the difficulty of this separation varies from one plant to another, and depends on the nature of the pesticide. At present, as each new pesticide is produced, a method is developed as quickly as possible by an empirical approach.

A method of general applicability would therefore be of considerable value, and, as the first step in the development of such a method, work has now commenced on a study of the behaviour of some twenty individual pesticides, using as a basis the method devised in the Laboratory for the determination of demeton-methyl.

As part of the work on a general method, determinations are being made of thimet residues in peas. "Thimet", an organic phosphorodithioate, is oxidized in the plant to an oxygen-analogue sulphone which shows much greater anticholinesterase activity than the parent thimet. Comparative determinations of phosphorus residues and anticholinesterase activity are being made to ascertain the nature and quantity of the residues in the crop.

The results of a study of the "Phosdrin" contents of fresh and deep-frozen vegetables are to provide the basis of a paper for publication.

Other work in progress includes a collaborative interdepartmental panel study of a method for the determination of malathion residues.

(c) Mercury Pesticides. In addition to collaborative work concerning residues on crops treated with mercury pesticides, determinations have been made, after the development of suitable techniques, of the relative volatilities of twenty mercury compounds. The efficacy of such compounds in sprays and seed dressing, and the toxic hazards associated with their use, are related to their volatilities.

Both static and dynamic methods were employed for preparing atmospheres saturated with the vapours of organo-mercury compounds, the former method proving more suitable for the less volatile aryl compounds, the latter for the more volatile alkyl ones. Measurement of the quantity of vapour in the saturated atmosphere was effected mainly by the use of the apparatus for the determination of mercury and its compounds devised in the Laboratory (Sergeant, Dixon and Lidzey, Analyst, 1957, 82, 27). In spite of some anomalies, it was possible to establish a broad relationship between vapour pressure and chemical constitution. A description of this work is being published.

The work on crop residues has been mainly related to the treatment of glasshouse tomato plants with aerosols containing phenylmercury salicylate. Determinations are being made on tomatoes sampled throughout the 1959 season in order to ascertain levels and rate of decay of the mercurial residues. The analytical method being used was developed in the Laboratory, and is now the subject of collaborative study by the mercury residues panel.

Mercurial Seed Dressings

At the request of the Department of Agriculture for Scotland work was undertaken on the analysis of samples of water-soluble mercurial seed dressings with the object of checking the identity of the organo-mercury compounds present in the formulations. Very few of the many papers published on the analysis of mercury formulations deal with this aspect of the problem. It was, therefore, necessary to adapt an existing method in the literature and to devise a new one for the characterizing of the organo-mercurials by the preparation of derivatives. It was found possible to make the acetylides of some of the commercially available organo-mercury compounds and the thio-cresol derivatives of some of the others. No one reagent or method was found to yield a complete series of characteristic derivatives but it was possible in all cases by a means of a combination of methods to establish the identity of the organo-mercury compound present. Advice was also given on methods for the termination of soluble organo-mercury compounds in dipping baths.

LOW VOLUME APPLICATIONS OF COPPER FUNGICIDES TO COFFEE

K. S. McKINLAY and E. T. MESMER, Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 269.

"Coffee rust, *Hemilaea devastairix*, is normally controlled in East Africa by applications of copper fungicides applied as high volume sprays using at least sixty gallons of water per acre. There is, however, considerable interest being expressed at the moment in the possibility of reducing the amount of water used and during March 1960, a field trial was laid down at the Jacaranda Coffee Research Station, Kenya, to investigate the effects of varying gallonage and copper concentration upon rust control in coffee. The C.P.R.U. carried out a series of physical assessments on this trial and the results of these are given below.

Sprays based on "Perenox" were applied by a small, man-carried, mistblower, the "K.W.H. Whirlwind". A gallonage rate of 7 gallons per acre, (50 cc per tree), was obtained by fitting a restrictor in the liquid delivery pipe of the "Whirlwind" and spraying two opposing sides of each tree for approximately ten seconds per side. Spraying in the same way with the restrictor removed gave 56 gallons per acre, (400 cc per tree), and by spraying four sides instead of two the gallonage was increased to 112 gallons per acre, (800 cc per tree).

The actual experiment was laid out in three randomised blocks each containing nine plots, i.e. one of each treatment. Immediately after spraying and at subsequent intervals, ten leaves at shoulder height, but otherwise at random, were taken from each of the twenty-seven plots. A procedure for the removal and analysis of the copper deposits is described.

In one block deposits of copper on upper and lower leaf surfaces were estimated separately immediately after spraying and some weeks later. Analysis of the data showed that at the first sampling the deposits on the lower surfaces were significantly higher than those on the upper at the 1% level and at the second sampling the significance of the difference had increased to the 0.1% level. Prior to this trial an experimental spraying using dyed water and filter paper targets had shown that more spray was hitting upper leaf surfaces, thereby substantiating the present results which indicate that the run-off on the more waxy upper leaf surface was greater than on the lower and thus although more fungicide hit upper surfaces less was retained.

The results suggest that from a purely physical aspect, and with some reservations discussed later, the most efficient use of a fungifi fungicide would be obtained with low volume sprays of the order of 7 gallons per acre and that once the volume of liquid used is increased to the point where run-off occurs fungicide is wasted in the liquid that runs off the trees. However, two further points must be considered. In the present trial only the gross deposit on fairly large areas was considered and it may be that, for rust control, uniformity of distribution over relatively small areas is most vital. A heavy copper deposit distributed as large drops might leave many untreated gaps where fungal spores might germinate and penetrate the leaves successfully. Secondly the more the volume of liquid is reduced the more difficult does it become to spread it uniformly over the whole tree and if low volumes are to be used it may be necessary to obtain a very carefully designed and tested air assisted blast sprayer. In any case these physical assessments must be treated with caution until the biological side of the trial is finished."

DOSAGE DISTRIBUTIONS ON COFFEE PLANTS

D. YEO and H. H. COUTTS. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 250, pp.16 including 9 tables; 8 figures.

"During research upon controlling insect and fungus pests of coffee", state the authors, "assessments were made of the dosages achieved upon the leaves of coffee plants. A statistical analysis of the data showed that there were considerable difficulties involved in comparing two dosage distributions, and that there were even greater difficulties in relating the physico-chemical data to biological effectiveness.

It is perhaps not generally realised that physico-chemical assessments are often unable to decide between two methods of application. In the absence of detailed biological data, dosage distributions can be compared in terms of criteria such as,

(a) uniformity of cover,

(b) high overall deposit,

(c) high deposits in important sites such as the under surfaces of leaves,

(d) persistence of deposit,

but such criteria are entirely physico-chemical and often of no immediate use in working out suitable and economic techniques for controlling a particular pest.

This can be illustrated graphically, such that two hypothetical distributions of dosage are so drawn that the arithmetic mean dosages are identical. For a highly mobile pest, which moves over many sites, both distributions might be expected to give comparable degrees of control because the same doses would be picked up.

On the other hand, the degree of biological control of a static pest is complexly affected by the variations in dosage from site to site, and it might be misleading to quote arithmetic, or even geometric, mean dosages as representative of a given dosage distribution. It is improbable that complete synthesis of biological and physico-chemical data will be possible, but at least it is important to record variations in dosage as well as mean dosages. A complete synthesis will only be feasible when the dosage distributions can be related to actual biological control, i.e. detailed information is available upon the degree of control achieved at given dosage levels. This might perhaps be possible for a pest such as leaf miner in coffee, and such information would then enable estimates to be made of the kill to be expected from various methods of application of a particular insecticide. It is hoped that this possibility will be investigated in the near future, by relating kills to dosages in known sites within the coffee plant.

The paper deals in detail with some physico-chemical assessments already made, and shows how the assessments may lead to improvements in design and in methods of application. It should be emphasised that the assessments were primarily to measure dosage distributions of actual field applications, and that the machines were not always used in the best possible way. Further experiments are planned but it may now be some time before they are completed because one author (H. H. Coutts) has now left the Unit, and the other is being seconded to another organisation for a considerable period.

ASSESSMENT TECHNIQUES. 2. PHOTOGRAPHIC PAPER

D. R. JOHNSTONE. Colonial Pesticides Research Unit, Porton.
Report No. 177.

Author's Summary

Fixed and glazed photographic bromide paper has been examined with regard to its potential usefulness as a sampling surface facilitating drop size measurements of insecticidal and other sprays. Drops of certain liquids sampled on the glazed surface form well-defined circular impressions or stains in the gelatin layer, of diameters which can be related to those of the impinging drops.

For a given liquid, the spread factor, i.e. the ratio of stain or impression diameter to droplet diameter, is not constant with varying size of droplet, being a function of droplet momentum at impact. Thus for greatest accuracy in subsequent measurements, calibration conditions should match those of the sampling application, in regard to droplet impact momentum.

A calibration for water droplets covering a wide range of size, and sampling under conditions such that impact velocities ranged between 2-8 m.p.h. yielded a linear relation of the form $D = 0.50(S)^{0.91}$ when impression diameter (S) was plotted against droplet diameter (D) on log-log graph paper (Fig. I). Maximum scatter over the range 0.02-2 mm corresponded to a deviation of 15% from the droplet diameter as predicted by the calibration line.

The method may be used satisfactorily with aqueous solutions, oil-in-water emulsions, and other liquids capable of penetrating the gelatin film, provided that the contact angle at the air/liquid/gelatin interface exceeds zero. In general, exceptions to the latter condition are liquids with low air/liquid surface tension, which wet the gelatin, and spread irregularly to form thin films.

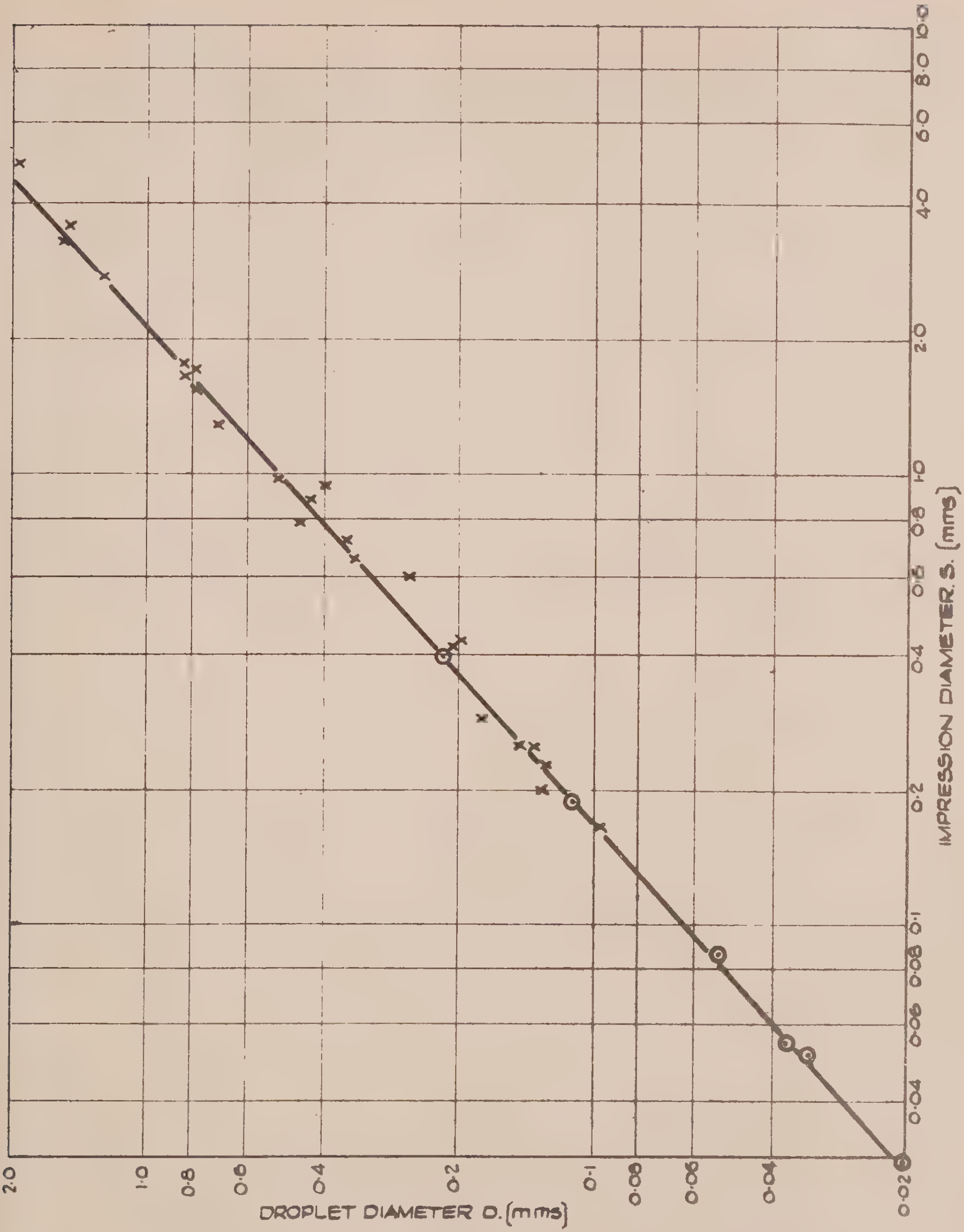

FIG I

X = DISTILLED WATER + 1% CROCEINE SCARLET (BY MICROBURETTE 1.)
⊙ = DISTILLED WATER (BY MICROBURETTE 2).

PERFORMANCE OF THE MODIFIED S.A.6 BOOM AND NOZZLE CROP SPRAYING INSTALLATION FITTED TO A DRAGON-FLY HELICOPTER.

D. R. JOHNSTONE. Colonial Pesticides Research Unit, Porton.
Report No. 175.

The author describes the technique of assessment, field procedures and the analysis of results. Requirements for the efficient aerial dissemination of spray fluid by helicopter are examined and compared with application from fixed wing aircraft. The nature of the helicopter deposit and its degree of penetration and the provision of underleaf cover is considered.

The following conclusions are made:

(1) A deposit with v.m.d. 250μ ± 10% is obtained with Porton flat fan spray nozzles size '0' jet area .0078 sq. cm., and 130 p.s.i. at the sprayboom, over the speed range 15-45 m.p.h. and at operating heights of 12-36 ft. At a nominal height of 20 ft the v.m.d. at lower and upper limits of this speed range is 275 and 230μ respectively.

(2) v.m.d. is increased to ca. 350μ when sprayboom pressure is reduced to 100 p.s.i. and the aircraft is flown at 12 m.p.h. at a height of under 20 ft.

(3) A deposit of v.m.d. 185μ ± 10% is obtained with '00' nozzles, jet area .0029 sq. cm., with 130 p.s.i. at the sprayboom, the aircraft speed being 8-13 m.p.h. at heights of 10-30 ft.

(4) Ground dosage equivalent to 0.25 lb of active agent/acre from a 2½% solution is obtained over an average effective swathe width of ca. 20 yds., with optimum number and positioning of active nozzles. Density distribution over the swathe is most even at 30 ft operating height, and is generally improved by having the nozzles closely spaced at the boom tips and widely separated towards the centre.

(5) Below 20 m.p.h. at 20 ft deposit density tends to be uneven due to variable impaction effects.

(6) Recovery of active agent on the ground is complete within broad limits of experimental error, despite loss of solvent by evaporation, which above 25 ft approaches 50%.

(7) Measured drift does not exceed 2% under any of the conditions investigated.

To the report is appended relevant numerical details, tables of results and 16 figures.

AIRCRAFT APPLICATION OF PESTICIDES IN EAST AFRICA.
XIX. A TREATMENT OF THE NORTH BLOCK CNUNGAI WITH 2½% DIELDRIN SOLUTION, 1959-1960.

G. F. BURNETT, D. YEO, A. W. D. MILLER and P. J. WHITE.
Colonial Pesticides Research Unit, Arusha, Tanganyika.
Miscellaneous Report No. 263, pp.12, tables 5, 1 sketchmap.

This report contains details of the block, method of treatment and the siting of fly rounds. Operational and entomological results are considered and the exercise is discussed at some length. An examination of costs is made.

Authors' Summary

The north block at Chungai, about 11 square miles of thorn savannah and thicket in Central Tanganyika, was treated between July 1959 and March 1960, in an attempt to eradicate Glossina morsitans and G.pallidipes. Dieldrin in 2½% solution in oil was emitted at 0.125 gallons per acre, eight times at approximately 4 weekly intervals. Swathe width was 55 yards, the aircraft, an Auster, emitted as it flew in both directions over the block.

The operation suffered delays and three applications were incomplete to varying degrees. Kills of G. morsitans per application appeared to be over 90% for males and 85% for females, but the final reduction of 99.63% could have been attained with consecutive mortalities of only 65%. It is suggested that this discrepancy may be due to the higher lethal dose required by pregnant females. G.pallidipes was also reduced by over 99%.

The experiment is compared with the previous year's in the same block using gamma BHC, which failed to exterminate the fly. It is concluded that a combination of reduced swathe width, greater volume dosage and smaller lethal drop together with improved flying technique and the more reliable performance of the disseminating equipment was responsible for the improved result. It is thought that without delays, interruptions, incomplete applications and, possibly, reinfestation, even better results would be obtained.

This was the cheapest and one of the most successful aerial operations carried out against savannah tsetse. Costs actually over ground were £301 per square mile; incidental costs due to the locality of operations were £66 per square mile. There is little chance of reducing the cost of flying directly, but economies are possible by the use of other insecticides or, more probably, by more efficient dispensing equipment.

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RECENT INSECTICIDAL OPERATIONS AGAINST TSETSE

SOUTHERN RHODESIA

Chiredzi River (1)

A northward extension of the south eastern fly-belt occurred on the Lundi River in 1959, accompanied by an outbreak of trypanosomiasis on Lone Star Ranch. Dieldrin was applied to riverine vegetation in the area during September-November, 1959. No further cases occurred on the Ranch during the period October 1959-March 1960. It is considered that the tsetse population in the area has been effectively controlled.

Spraying Operations: Riverine fringe and alluvial woodland along the lower 10 miles of the Chiredzi, and the riverine fringe along 8 miles of the Lundi River were selected for treatment with dieldrin, a total of over 3,000 acres. The dieldrin was applied as a 3.6% emulsion. This concentration was used in the hope of avoiding defoliation, which may occur when a 5% emulsion is applied. A second application of a 1.8% dieldrin emulsion was planned to follow 2 months after the first. Ten "Motoblo" machines were used to apply the insecticide. These are motorised, shoulder-mounted, mist-blowers. Each was attended by a team of 5 men.

It was decided that a sufficient cover of insecticide would be laid down if it were applied in parallel swathes, 40 yards apart, each swathe being 5-10 yards wide. Except in the initial stages, no traces or paths were cut for the machines. It was found that the 40 yard interval could be maintained by eye where the whole span worked as a unit, in line abreast. All foliage and tree boles along the swathes were sprayed to a height of 10' above the ground. Samples of the deposit were obtained from filter papers pinned on tree boles, 5' above the ground. The mean of 10 deposits was 337 mg per square metre, estimated by the Colonial Pesticides Research Unit, Arusha. This figure can be compared with those obtained in work with 2% dieldrin at Voi, Kenya where deposits of the order of 160-230 mg/sq.m were obtained. In work with 5% dieldrin in Uganda a mean deposit of 790±300mg/sq.m was obtained.

The first application of 3.6% dieldrin emulsion took place during September, October and November 1959 in a total of 15 working days. The second application of 1.8% dieldrin was started in November, but had to be abandoned owing to the onset of the rains. During the first application, 1655 gallons of 3.6% dieldrin ware applied to

3125 acres of woodland and riverine fringe, at a rate of 0.6 gallons per acre. This is equivalent to 0.105 gallons of 'Dieldrex 15" per acre, a figure comparable to that obtained in Uganda, (0.118 gallons of "Dieldrex 15" per acre). The methods of application in the two operations differ considerably however. Each machine laid down 39 miles of swathe, and operated for 73 hours. The approximate costs are given below. On the basis of these figures, the cost per acre sprayed was approximately 6s. 10d.

	£	s.	d.
Insecticide - 331 gallons "Dieldrex 15"	701	14	6
Fuel (approximately)	20	-	-
Labour (approximately)	331	-	-
Transport (approximately)	70	-	-
	£ 1122	14	6

NORTHERN RHODESIA (2)

A technique has been evolved using discriminative clearing and a thermal aerosol of 1.5% gamma BHC applied from the ground by means of a TIFA. The method has been used with good results in two isolated pockets of Glossina morsitans infestation and also in an area where fly had encroached, once the encroachment had been severed from the parent infestation.

NORTHERN NIGERIA

Insecticidal Control (3)

When the use of insecticides against Glossina tachinoides was first considered, the first thought was that they would be of most use in the atypical sites, where clearing methods could not be used. However, once their potency, and in particular, an indication of the exceptional persistence of residual insecticides, had been established, it was obvious that large-scale application to the normal sites might be practicable, by virtue of the very qualities that made clearing effective - the linear distribution of G. tachinoides and its restriction to the river beds during the dry season.

Thermal Aerosols: Some trials of the effectiveness of thermal aerosols were carried out early in 1954, in a dry river bed which was an exceedingly popular breeding site. Using a Swingfog Pest Control Unit,

G. tachinoides was shown to be highly susceptible to both BHC and DDT fogs, up to at least 40 yards from the point of emission of the fog. However, the need for a number of applications to deal with the emergent flies limited the method. There were other considerations which also did not favour it. The larger types of machines could not be used, in view of the terrain, while it was not possible to obtain large numbers of portable machines. Thermal aerosols need high humidities and conditions of inversion, which only obtain at night in the dry season. (The wet season is out of the question, as movement is so limited.) There has therefore been no further development of the method as a means of human trypanosomiasis control.

Residual Insecticides: The first experiment of spraying the vegetation of a G. tachinoides habitat with a residual insecticide, was carried out in late 1953 (i.e. early dry season). The site was an isolated mango grove cut down ten years previously. It stood on the bank of a wide sandy river almost devoid of vegetation. Irrigation trenches ran throughout the cleared areas of the grove and no doubt assisted in maintaining favoutable conditions. G. tachinoides was shown to be concentrated in and around only four groups of trees., this becoming more definite as the dry season set in. A 5% suspension of DDT in water (from 50% paste) was applied to these four sites, the foliage being sprayed up to a height of 4 feet, while particular attention was given to the ground covering of seedling mangos and fallen leaves, in order to catch the emerging flies.

As the essence of residual spraying against tsetse is that a toxic deposit must be maintained for the longest possible pupal period from the date of spraying, it was thought that two or even three treatments would be necessary, in view of recorded experience elsewhere in Africa at that time. In actual fact, nil catches were recorded immediately after the first application, and were maintained. Rough tests of the deposit showed it still to be effective after 57 days. A point which was noticed was the possible effect of a sprayed area of new leaf growth. In the case of mango seedlings, leaf area may be doubled in two or three weeks, so that the treated surface is now only 50% of the whole.

Generally the experiment was more successful than had been hoped for A. tachinoides was eliminated at a cost of 24 lb of 50% DDT paste and a very small labour charge. The alternative would have been drastic thinning-out and felling of the mangos, involving much greater labour costs, and arguments over compensation etc.

The possibilities of insecticides having been indicated by the above, and by various applications of it, such as to a grove of fan-palms (Borassus aethiopum), a unique G.tachinoides site, the first large-scale field experiment involving linear riverine spraying was commenced late in 1954, in Benue Province. This was primarily aimed at G.palpalis, but a low density of G.tachinoides was present, and much practical experience was gained. The outcome of the experiment was that DDT applied as a wettable powder was found to have insufficient persistance in the South Guinea Savannah zone, even if repeated applications were made.

The River Sulma Experiment: To test the effectiveness of spraying a purely riverine population of G.tachinoides with DDT, a site on the River Sulma in Katsina was selected, and observations on fly density etc., were begun early in 1956. The area lies on the border between the North Guinea and Sudan Savannah zones. The neighbouring rivers had all been cleared, or were cleared between 1956-57, so that the site was as isolated as possible. Close observation was kept of 8 miles of river, while less detailed observations were made on the remaining 28 miles. A system of motorable tracks was made to facilitate inspection, movement of insecticide, etc.

Spraying with 5% DDT suspension in water (from 50% wettable powder) began in early 1957, using a team of six pressure knapsack sprayer. The 36 miles were completed in 9 days, the average rate of application being 33 lb of 50% DDT powder per mile. Although there was an immediate drop in the fly population, a few still persisted, and a second partial application of DDT was made two weeks after the first. This was done not from the fear of short persistence, but because it was felt that some places, due to inexperience, had not received an adequate coverage. The average rate of this application was 19 lb of 50% DDT per mile. The cost of the two applications was about 20% of what would have been the cost for clearing.

The fly population declined rapidly, a nil catch being registered in the 8 mile stretch, in the two months (February and March) following spraying. A single fly was caught in April and then nothing until a single fly was caught in October. A check in May 1958 however showed that flies were established in fair numbers, and overall re-spraying was carried out in early 1959. A check one year later (February 1960) again produced one fly.

Further Applications of Linear Riverine Spraying: The Sulma experiment showed that riverine spraying was a feasible operation, and that much more extensive projects could be undertaken. In early 1958 operations were commenced on the headwaters of the River Kamanda in Zaria Province. Here, rather than having long continuous stretches of sprayed river, cleared barriers were interpolated, with a view to limiting any possible invasion to one area. In all, five barriers were cut, a total river length of 39 miles being involved. Included was a terminal barrier abutting on to the un-sprayed part of the system. Isolation of the sprayed area depended mainly on the concept that water-sheds can act as barriers to the movement (at random) of G. tachinoides, although some of the neighbouring river systems had in fact been cleared during previous projects.

The river length sprayed, totalled 187 miles and was completed in 27 days by 9 sprayers. One treatment only was given, the average rate of application being 29 lb of 50% DDT powder per mile applied as 5% suspension. G. tachinoides immediately disappeared, and after 4 months, were still not apparent. As it was now considered that all breeding must have ceased, the scheme was deemed to have been successful, and regular fly-rounds were discontinued. However, a check 22 months after spraying showed that flies were present in low density dispersed over the area.

In early 1959, the headwaters of the River Jare in Katsina Province were given a single application of 5% DDT suspension in water. Again the area was divided up by cleared barriers, totalling 88 miles, while 77 miles of motorable track were constructed. A total of 394 miles of river were sprayed in 45 working days, using 14 sprayers, the average rate of application being 20.5 lb of 40% DDT wettable powder per mile. In all, 482 miles of river were treated at an overall cost of £14 10s. 0d. per mile (i.e. less than half the cost of clearing alone). To date, no flies have been reported, except in two isolated sites, where they obviously had never been eliminated, due either to the sites having been overlooked, or bad spray application. These have now been treated.

The Flood Plain Areas: As already pointed out, the flood plains of the Lake Chad basin rivers are in places heavily wooded, with often high densities of G. tachinoides and G. morsitans. Intensive farming, and a relatively high human population up to the edge of the flood plain, tend to isolate these woodland areas, and as lateral tributaries are rare, prospects for control are generally good. In addition, the dry season is extremely severe, and G. tachinoides in particular is hard-pressed.

The River Duddurun Gaya in Kano Province is an example of such a river. Clearing had been done along it, in view of the high local rate of sleeping sickness, but had been forced to a stop by the extensive woodland encountered. G. tachinoides was restricted to a few mango groves. ..

The first major concentration of *G. tachinoides* was encountered at the beginning of the flood plain and extended through 7 square miles of woodland, of an average width of 1 mile, before the end of the old clearings were reached. It was considered desirable at the time, to spray a large part of the woodland as well as the riverine vegetational zone, in view of the fact that *G. tachinoides* was ranging through it. Later work has shown that this was probably unnecessary. Spraying, first of the riverine zone, and then the woodland, commenced in February 1958, and was completed in one month. Approximately 3 tons of DDT 50% wettable powder (used as 5% suspension) were applied in one treatment. Complete elimination of *G. tachinoides* was achieved, a result which has been maintained to date.

From this area of woodland, the old clearings extend northwards for about 8 miles. A belt of very heavy woodland is then encountered, which extends for about 23 miles (approximately 70 square miles). Several distinct vegetational associations are present. There is a dense riverine "forest" ranging in depth from a few yards to mile or more. This is the main habitat of *G. tachinoides*. Beyond is woodland (mainly of *Acacia seyal* and *Anogeissus leiocarpa*), which gives way to more open savannah (*Combretum* spp., *Terminalia* spp.). This in turn opens into farmland. In the woodland are numerous "forest islands", thickets, and Tamarind-termite-heap associations. The latter are more significant from the point of view of *G. morsitans*, which was also present, rather than *G. tachinoides*.

Part of this area has been kept under observation since June 1958. Records show that in the wet season, both species ranged through the woodland, but that in the early dry season, *G. tachinoides* began retreating to the vicinity of the water-courses, and by middle of the dry season had apparently vacated the woodland. *G. morsitans* also retreated from the woodland, but more slowly, and did not concentrate into the riverine zone until the end of the dry season. The "front islands" were not investigated on this occasion, but other work (Nash 1937) has established their importance as concentration sites for *G. morsitans*.

In early 1959, an experiment in limited spraying was carried out. No efforts were made to isolate the sprayed area, which involved 12 miles of river. Only the riverine zone and thickets in its vicinity were sprayed with 5% DDT suspension. A high degree of local control was obtained, and it was several months before flies of either species reappeared, and then only in very low density.

Spraying of the whole belt began in January 1960, and is in progress at the time of writing, using 5% DDT suspension on the riverine vegetational zone, and, as it also required to eliminate G. morsitans, on the woodland thicket. Preliminary results are encouraging. Persistence tests of insecticide deposits, carried out as accurately as field conditions allow, indicate that they are still adequately toxic after 60 days.

Southern Zaria Province: (4)

As a result of survey work in Southern Zaria Province, Northern Nigeria, it was decided to introduce a two phase experiment on the control of G. palpalis. A small river basin containing about 180 miles of river was selected as an experimental area, and descriptions of the climate and vegetation within the area are given. The methods of reclamation and their effects on the G. palpalis population are mentioned. It was found that G. palpalis could be eradicated by a single application of 2% dieldrin and that wet season re-invasion of the reclaimed areas could be controlled by regular applications of 3% dieldrin to the headwaters of reclaimed streams on the borders of the experimental area. The cost of labour and materials for eradication was approximately £8 per mile of river while the chemical barrier was about one third the cost of physical barrier.

Southern Guinea Savannah: (5)

4% dieldrin emulsion when applied to the riverine vegetation in the Southern Guinea Savannah has caused the eradication of G. palpalis over a large area. There is as yet no sign that the fly is re-establishing itself (after 14 months). There are indications that a 1.1% deposit of dieldrin emulsion is insufficient to eradicate G. palpalis. In all probability 2% dieldrin is sufficient to eradicate G. palpalis, but this has yet to be tried on a large scale. There are indications that a deposit of 4% dieldrin remains toxic to G. palpalis for more than one year.

There is at present a definite need for a satisfactory method of biological or chemical assessment of dieldrin deposits in the field. At present we are limited to spraying river and then waiting for a year or so for the results - a method which is extremely slow and not always certain. Bio-assay using wild caught flies is notoriously unreliable, even when sufficient numbers can be caught. (Most of the areas in which sleeping sickness is prevalent support a relatively low fly population). Laboratory facilities are not available in these places while sending samples of foliage to a laboratory for chemical analysis has so far proved unsatisfactory.

With no definite methods of determining the loss in toxicity or availability of an insecticide deposit with time it can only be hazarded that a 1.1% deposit of dieldrin might represent approximately the minimum deposit from which a relatively inactive fly, such as G. palpalis might pick up a lethal dose. With a little weathering, such as might take place over 2 to 3 weeks, the remaining insecticide in the deposit would then be reduced below the critical level, and any fly touching the deposit thereafter would then pick up a sub-lethal dose. The failure of the 1.1% dieldrin trial supports this view. Successively stronger concentrations of insecticide would presumably take longer to weather to below the critical level thereby increasing the persistence. It now remains for the optimum economic concentration to be determined. Present indications are that this is in the region of 2%.

Sudan Savannah Zone: (6)

In 1956 a method was devised of eradicating Glossina morsitans and G. tachinoides in the Sudan savannah zone of Northern Nigeria, using selective spraying of DDT by knapsack sprayer in the dry-season contracted habitat of the fly. The method has been developed during the past three dry seasons into an efficient routine which offers rapid and reliable eradication at a cost in insecticide (2.5% DDT w.p.) and labour of about £100 per square mile of dry-season habitat or proportionally more cheaply if the rainy-season range of the fly is taken into account.

KENYA

Conspectus of Measures Against Tsetse Flies (7)

Passive protection against tsetse flies:

- Fly-proof road and rail vehicles
- Movement of animals by night
- Fly-free cattle corridors
- Repellents
- Insecticides on animals

Prevention of the spread of tsetse flies

- Barriers
- Game fences (against carriage by game animals)
- Fly piquets and cleansing chambers
- Measures against flies on trains

Attack on tsetse flies

- Direct
    - Hand-catching
    - Traps
    - Insecticides
- Indirect
    - Through the habitat
        - Direct (bush clearing)
        - Indirect (land useage, burning etc.)
    - Through the food supply
        - Game destruction or control
    - Through natural enemies
        - Parasites and predators
    - Through the mating system
        - Biological sterilization
        - (Radioactive sterilization)

Combined methods

Use of Insecticides (7)

Inseciticides have been used in four ways:

(a) Applied to vegetation from the air (aerial spraying).

(b) Applied to vegetation from the ground (hand spraying).

(c) Applied to the surface of bait animals or suitable artefacts, large numbers of which are placed in the habitat.

(d) Introduced into the bloodstream of bait animals which are then spread throughout the habitat.

It is necessary to make a further distinction in the use of insecticides which cuts across the classification just given, and that is the distinction as to whether they are used for residual or merely immediate effect. The same insecticides are used in either case, and the difference depends on the amount or concentration of deposit that is laid down by the particular method used. Thus in the case of fogs or smokes the deposit is small and the effect is immediate and transitory; similarly with aerial spraying the concentration of insecticide that it is economical to use is so low that the principal kill takes place at the time of application and the residual effect is small or negligible. All other methods (hand-spraying etc.) make use of residual effect: the deposit of insecticide is high and consequently its lethal power persists for a considerable time. As will be obvious, treatment has to be repeated more frequently in the former case than in the latter.

Insecticides share with other methods of direct attack a particular disadvantage: they leave the habitat unchanged and hence ripe for re-invasion by tsetse flies. Where eradication is the aim, therefore, such methods must be applied in areas which by natural or artificial barriers are completely secure from the possibility of re-infestation; otherwise the measures are wasted.

(a) Aerial spraying, not yet tried in Kenya, has been successfully used in Zululand, Tanganyika and Uganda. Discriminative spraying analogous to discriminative clearing (v. infra) has been tried. For reasons connected with the breeding cycle applications usually take place fortnightly. The method is economic only for large areas, preferably bounded by natural barriers. Since it depends for success on the penetration of an aerosol into the resting places of tsetse flies, difficulty is sometimes caused by the filtering effect of heavy top-storey vegetation. This could be relieved by preliminary application of a defoliant.

(b) Residual insecticides on cattle or attractive 'screens' have only been tried as a definitive control measure with cattle, and fell short of success. The method has been tried in Kenya only on an experimental scale against G. austeni.

(c) Attempts to feed insecticide to cattle in such quantity that their blood is lethal to haematophagous flies have been persistently made in Kenya. The main difficulty is that the required concentration of benzene hexachloride, aldrin or dieldrin is very nearly toxic to the animal. A small field experiment with treated cattle in a limited infestation of G. austeni reduced flies considerably but not completely.

(d) It is with hand-application of insecticide to vegetation that the greatest practical success has been obtained, though so far only against G. palpalis. The first large-scale success with this method was achieved in the Nyando river basin of Kenya. Later, improved methods in the same area resulted in the extermination of G. palpalis from some 300 square miles - the natural limits of the infestation. Thus a complete fly-belt was extirpated and the problem of re-infestation did not arise. The method is now being applied to an even larger area on the Kuja and Migori rivers in South Nyanza. It is primarily directed against human sleeping sickness, though of course it is effective against such animal trypanosomiasis as can be attributed to the presence of G. palpalis. It has recently been adopted by neighbouring territories. For a detailed account the Annual Reports of the Kenya Veterinary Department should be referred to (1953-57). During the past two years research has been directed towards adapting this measure against a far more important vector of animal trypanosomiasis, G. pallidipes. Because of the widespread distribution of this fly discriminative spraying is essential and great subtlety of method is required; nevertheless, the first experiments have been extremely promising.

The measure just referred to involves the residual use of insecticides (DDT or dieldrin). As to the other possible use, a few experiments with ground-applied fogs and smokes have been carried out in Kenya and Tanganyika against G. palpalis and G. swynnertoni. Using proprietary machines and repeating the treatment fortnightly a spectacular reduction of flies was achieved in both cases; but it never reached eradication, quite possibly because neither area was completely isolated from re-infestation.

Despite the success and promise of direct attack with insecticides it is the indirect measures against tsetse flies that are still today the most widely used, the most certain in their outcome, and usually the most efficacious. Of them, measures directed against the fly's habitat are in practice predominant, those directed against its food supply less prevalent or more used in conjunction with other measures, and the rest are not yet of practical value. While in the next few pages these divisions of the subject are for convenience discussed separately, it must be borne in mind that most often several of them are used together; indeed, more than this, direct attack and chemotherapeutic methods are frequently brought to bear as well; the skilful combination of techniques is the essence of economic trypanosomiasis control.

South Nyanza (8)

The Kuja-Migori Scheme was started in 1955 to eradicate G. palpalis from some 300 miles of the Kuja and Migori rivers. The work during the following three years was so successful that a plan has now been drawn up which aims at the complete extermination of this fly from the Colony. Since the scheme began one thousand square miles of South Nyanza have been rendered fly-free. This has involved the spraying of 692 miles of river and 63 miles of lake shore with 'Dieldrex' at a cost of approximately £50,000. Four applications of 1.8% 'Dieldrex' are given at three-weekly intervals to specially prepared lanes through fringing thicket on the lake shore and along both banks of the rivers.

Motor-driven "Kiekens Dekker Whirlwind" mistblower and "Eclipse Warley" pneumatic sprayers have been used. The penetrating power of the former is very much greater than that of the "Eclipse" sprayer but both are effective.

This year a further 134 miles on the Kuja and Migori rivers were treated, so that the task of supervising the ever-growing field staff required to patrol the sprayed areas has become increasingly difficult. Large labour forces have been required to keep open the survey paths and the amount of progress made during the year was severely limited owing to an insufficiency of funds. However, experimental work has indicated that the use of Harris traps may make it possible to maintain an effective check on treated areas and thereby avoid the cost of maintaining an ever increasing field staff.

On the lower Migori section of the scheme, which extends from the junction of the Kuja and Migori rivers to a point three miles below the bridge at Migori trading centre and include the rivers Munyu and Miroche, no catches of G. palpalis were recorded. During the first half of the year, a portion of the Upper Migori, nine miles above the road bridge, was successfully maintained as a "buffer" by spraying it with 1.8% 'Dieldrex' once a month; this prevented re-infestation of the treated areas by G. palpalis from the heavily-infested country above this block.

Also during the year a further 34 miles of the Upper Migori section were rendered fly-free. Survey work has shown that the limit of the G. palpalis infestation on this river is about eighteen miles upstream from Kihancha. The fly becomes less and less dense as the altitude increases, so that it is very difficult to determine whether or not it is present in some localities, as there is a vast network of heavily wooded tributaries in the Kihancha-Lolgories zone. Very careful work will be required in order to determine which of these will require treatment. However, surveys have shown that running water may indicate the presence of G. palpalis in this area as there are many well shaded dry river courses which are fly-free and which at lower altitudes would provide suitable habitats.

The Lower Kuja and its tributaries including the Angoche, Ondoiche, Ratioenya and Tito and the Upper Kuja have remained fly-free throughout the year. The Kuja delta, however, has been a source of worry as 5 G. palpalis were caught in this area. The delta zone was re-treated with 'Dieldrex' and by the end of the year had had two applications. It is not known where the flies came from.

Work continued in the Kabuoch forest through which the Kuja meanders, by cutting and spraying parallel lanes at intervals of 200 yards running from the river to the forest's edge. The last fly to be caught in the Kabuoch forest was taken during March.

On the Upper Kuja and its tributaries 69 miles were treated with four applications of 'Dieldrex' and apart from a few tributaries of the Sare river which have still to receive a third and fourth application, no more work will be required on this river system. Investigations will be carried out upstreams beyond Kitere but fairly recent surveys have shown fly to be absent above the limit of the present operations.

Cost of G. palpalis eradication is assessed at £57 per river mile.

Lake shore spraying provides a further striking example of the success of this method of dealing with G. palpalis. Few difficulties were encountered although in several sections swamps prevented access to the fringing thicket and spraying had to be done from the lake as well as from the mainland. The section of the lake hinterland immediately north of the Kuja mouth where there are numerous swamps surrounded by fairly dense vegetation, has been traversed by a grid system of lanes but surveys have so far indicated that G. palpalis is now confined to the lake shore only.

Assisted by a contribution of £2,800 from the South Nyanza African District Council, the spraying begun in May has rendered 45 miles of the lake shore fly-free, from the Tanganyika border northwards. An additional 18 miles have received three applications of insecticide and spray lanes have been prepared as far as Kitawa, 81 miles from the Tanganyika border.

Lake Victoria (9)

By spraying paths cut through the thicket on an isolated peninsula in Lake Victoria with dieldrin four times at monthly intervals, it was found possible to exterminate a dense population of G. palpalis at a cost of Shs. 26/59 per acre. The insecticide spray was prepared by diluting "Dieldrex 15", an 18.2% dieldrin emulsion with water, to a strength of 1.8% dieldrin. "Kiekens Dekker" portable mistblowers were used for applying the insecticide.

Coda (10)

In the fourth group of papers the results and problems of control by insecticides were described and discussed. Outstanding amongst these was an account from Southern Rhodesia of the application of residual insecticides, based on the records of infection of herds in an area where the numbers of advancing tsetse were so low that ordinary methods of survey failed to reveal them; this control by insecticides was an emergency measure, pending more permanent control by methods of discriminative clearing. In a most important paper, from Kenya, a new and promising development in the use of residual insecticides against G. pallidipes was described; this showed success from the application of the insecticide round the periphery and along a grid of paths through the infested area only, instead of application throughout the area. A series of papers from N. Nigeria demonstrated a point made by the delegate from Kenya, who drew attention to some difference, possibly in the severity of the climate, between conditions in East Africa and in Northern Nigeria, which seems to give success in the use of insecticide with much less expenditure of effort in the latter area. A plea was made for some explanation of the resurgence of tsetse some considerable time after successful applications, and for information on the susceptibilities of different species of tsetse to the various insecticides, and for field methods for the determination of the persistence of insecticides in the field. Another communication from Nigeria illustrated the application of more precise knowledge of the exact location of tsetse in the field to insecticide control and suggested three possible lines of development in the future - more specific application of insecticide by the treatment of selected species of trees only; reduction in amount of insecticide used by spraying vegetation only up to a certain height determined by knowledge of the resting habits of the tsetse in the particular situations concerned, or only to trees of a certain diameter, and even further reduction in the concentration of insecticide applied. A valuable review of methods of insecticidal control completed this group of papers and in them it was stressed that selective application appeared to be the most promising line of development for this mode of control. A need for standardisation in the presentation of results was emphasized. Problems of follow-up and detection of residual or resurgent flies were discussed and the use of test herds of cattle in this respect was suggested. Resistance was discussed and the general view seemed to be that, at present anyhow, this did not seem to be a serious problem.

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ECONOMICS

We are proposing to add a section on the economics of pest control to our journal and we will be glad to receive contributions for publication from our readers anywhere on these lines. We visualize three main groups of articles or abstracts:

(i) The general economics of pest and disease control, for example the following: (mentioned under Literature Noted PANS. A. 6. (3.) Pest Control.) "The Economic Theory of the Use of Pesticides, Pt. I, P. M. Hillebrandt, J. agric. Econs. 1960 13.464-74" and "Effect of Certain Organic Pesticides on the Yield of Crops", D.S. Rae, Current Science - 1959, 28. 57-8 (PANS 5.(3) p.347).

(ii) Costs of any particular operation or studies of incidence of pests pointing to the need for pest control, for example the abstract printed below, A. H. Strickland "Pest Populations that merit control" - (XIth International Congress of Entomology - Vienna, Aug. 1960).

(iii) The current prices of basic pesticide material at different centres.

PEST POPULATIONS THAT MERIT CONTROL

Summary of Address by A. H. Strickland
to the XIth International Congress of Entomology

Vienna - Aug. 1960

The practical man is interested in the level of pest attack in his crops, but finds it difficult, as does the research worker, to relate pest levels to potential damage to the crop. Some such relationships have been established in England and Wales, for instance oat yields and frit fly (*Oscinella frit*) and Brussel sprouts yield and aphid (*Brevicoryne brassicae*) but the standard errors of the observation are large. A 6.5% first generation frit attack will on the average, reduce yield by 2 cwt. of grain, but the P = .05 limits are 0.4 and 4.7 cwt. The value of 2 cwt. oats is about the same as two sprays with DDT so this is about the marginal limit for treatments. In 17 commercial field trials, Empson (1958) has shown that sprays are marginally profitable. The average shoot attack in England and Wales is just under 6.5% and all we really know is that half the crops are probably worth treating each year.

Critical levels of Attack: A "critical" level of attack, above which treatment is worth while, is defined as "one that uses a part of the host productivity equivalent in value to the practical costs of control". Some critical pest levels per acre are:-

10,000	alate cabbage aphids, Brussels sprouts
400,000	apterous cabbage aphids " "
1 million	*Toxoptera graminum*, wheat in Spring
1 million	springtails (*Bourletielle spp.*) germinating crucifers
320,000	frit fly larvae - young oats
50,000	wireworms (*Agriotes spp.*) maturing potatoes

Often when a pest is present in large enough numbers to attract the farmer's attention, it is well above the critical level.

Predicting Critical Levels: Problems of prediction arise under the heading of:

(i) Arrival

(ii) Population Density and

(iii) Activity

Trapping to estimate arrival shows bias according to time, sex and species and for instance, insectary rearing is said to give better codling moth data than trapping. Longer term predictions have been based on the previous year's weather and density of overwintering stages of the pest.

Besides knowing when pests are arriving, where treatment is needed, is also important. Detailed annual surveys can show where critical infestations arise, however to do this with oats in England and Wales 1,200 crops would need to be sampled, and the requisite staff would not be justified for oats alone. A detailed survey of adult and larval frit activity has been started to see if warnings based on concurrent observations on about 40 crops can be given from weather and pest activity during the month of May. This would rationalise spray usage for frit control with a minimum of administrative routine.

Economic Information in this issue of PANS:

Liver Fluke Control - Veterinary Research - Weybridge (p. 380)

"Santobrite" (sodium pentachlorphenate) used as a molluscide at 10 lb. per 30 gallons of water per acre, cost about £25 per acre when hired equipment was used, and was less than the cost of using copper sulphate at 28 lbs. per acre.

Tsetse Fly Control: Some details of the cost of spraying operations against Tsetse Fly are given in this issue of PANS, and are summarised here:-

Area	Spray	Cost	Notes and PANS reference
Chungai Tanganyika 11 sq. miles	Dieldrin 2½% soln. at 0.125 g. per A. at 4 week intervals	£301 per sq. miles of which £66 due to locality	Auster aircraft 55 yd. swathe PANS (p. 418)
Chiredzi S. Rhodesia 3,125 Ac.	Dieldrin emulsion at 3.6% and then at 1.8% 0.105 g. per A.	Per sq. mile. Dieldrex 15 - £144 Fuel - 4 Labour - 68 Transport - 14 £ 230	Approximately 6/10d per acre (PANS p. 482)
Sudan Savannah N. Nigeria	DDT. 2.5%	per sq. mile of dry season habitat protected £100	Selective spraying by knapsack (PANS p. 488)
Kuja-Migori S. Nyanza 300 mile run of river	Dieldrex 1.8% four applications at 3 weekly intervals	£57 per river run mile for eradication of *G.palpalis*	Eradication scheme started in 1955. 491) PANS (p.
Lake Victoria	Dieldrin 1.8%, 4 times at monthly intervals	£1.6.7d. per A. dense population of *G. palpalis* exterminated.	Portable mist blowers. (PANS p. 493)

Finch (Quelea) Control Kenya (PANS p. 410)

A total of 73.8 million birds were destroyed by spraying with 516 gallons of parathion on 1,050 acres. The ex-factory cost of the chemical we estimate of £2,640 i.e. £2 10/- per acre of £358 per million birds.

Capsulated Pyrethrum Concentrate, Kenya, for Antestia Control Testing

The capsules mentioned on p. 411 can be obtained from R. O. Hamilton Limited, Box 12030, Nairobi. Price sh. 1/25 each. They are called "Pytest".

PRICE OF BASIC PESTICIDE MATERIAL:

The following table gives the prices of basic pesticide material as quoted in the commercial press or to us in November, 1960. Unless otherwise stated, they are f.o.b. or ex-works prices for bulk quantities, and are entered here to give a rough comparison so that a cost/efficiency appreciation can be made as between different products.

Prices for raw material delivered in any particular area or country may well be different from the above, and are best ascertained from the manufacturers' local companies or agents: the same criterion also applies to formulated products.

The prices are calculated to the short ton (2,000 lbs.) and exchange is taken at £1 = $2.80. The actual early November dollar quotation is $2.81 9/16 - 11/16.

	New York		London	
Product	Price per short ton	Notes	Price per ton	Notes
Aldrin tech.	£707	fb. drms. dlvd.		
BHC. 12½% gamma	50	low gamma rate works.		
14% "	75	high gamma rate dlvd.	£71	
25% "	134	High " " dlvd.		
Lindane 99.5% gamma	1,522	250 lb. drms	1,008	1 cwt. drms f.o.b.
		2½ t. lots dlvd.		
DDT. tech.	171	pwd.	250	WHO grade SI tech/
Dieldrin, tech	1,321 to 1,357			
Endrin, tech	1,930	100% basis 100 lbs. or more		
2,4-D	286	cl.drs.bgs.frt eqld.	258	

	New York		London	
Product	Price per short ton	Notes	Price per ton	Notes
Cube root	£150	5% rotenone bags. tl. works		
Nicotine	750	sulphate 40% drms. frt. alwd.	£1,300	95/98% equiv to £540 for 40% matl.
Pyrethrum extract	20 per Imp. gall.	10% pyrethrins		
Lead arsenate	short on £218	acid frt. alwd.	125	
White arsenic	£32	wrks.	£40-£45	ex-store
Ground sulphur	£37½	brls. at mines		
crude ground			£14¾-£16½	
Copper sulphate	£93	99% bgs. cl. wrks.	£70	f.o.b. Liverpool
Copper oxychloride			£182	56/58% Cu.
Cuprous oxide	£359 £347	97% 90%	£181	84/86% Cu.
Malathion	£646 - £722		£650	Premium grade (odour reduced £825)
Parathion	£600		£400	

Key

fb. dms	- fibre drums
dlvd.	- delivered
bgs.	- bags
frt.alwd.	- freight allowed
brls.	- barrels
wrks	- ex works
cl.	- car lots
frt.eqld.	- freight equalised
matl.	- material

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